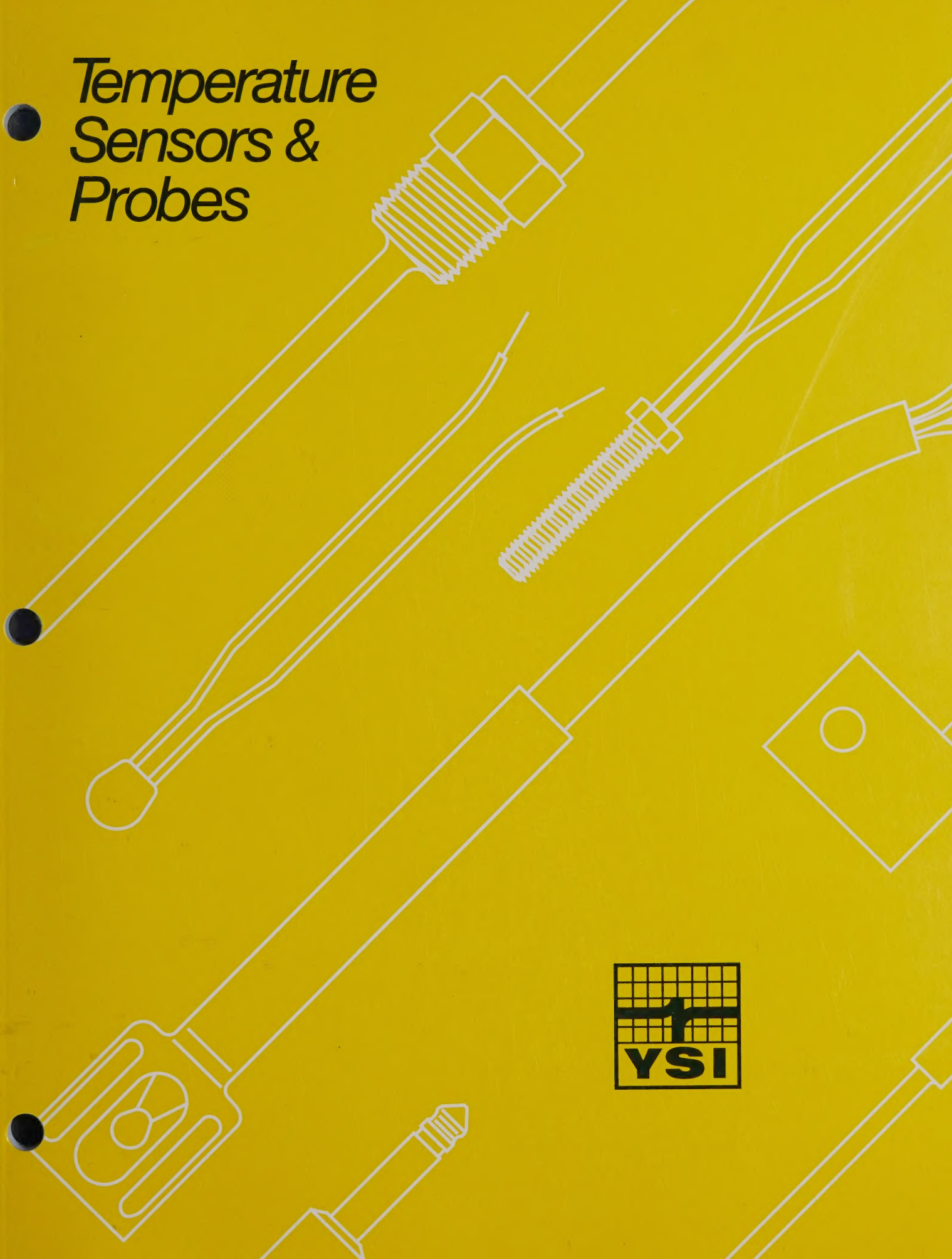
Temperature Sensors & Probes



YSI

YSI is an employee-owned company

From a partnership in the Antioch College science building in 1948, YSI has become a company that provides sensors and instruments for measurement and control to markets around the world. Through an employee stock ownership plan, every employee is also an owner.

Our mission is to be the recognized leader in selected measurement technologies and to provide the tools to enrich human life and protect the earth's resources.

We're here for you

We've published this expanded catalog to make it easy for you to specify our sensors and probes.

- Every configure-to-order probe has its own page that details all the options.
- Our off-the-shelf probes offer quick delivery of the most popular styles and discount pricing.
- Application notes, thermistor theory and how to use our Thermilinear components are also included.

Our customer service team is ready to help you select the right sensor or probe for your application. Call or fax us.

▼ **800 765-4974**

▼ **513 767-7241**

▼ **Fax 513 767-9353**

YSI INCORPORATED
Yellow Springs
Ohio 45387 USA

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Thermistors at YSI

YSI developed the first interchangeable thermistor probes in 1955 and the first line of precision interchangeable thermistors in 1961. In 1982, we introduced the first precision interchangeable glass-encapsulated thermistors. We have improved these products and expanded them into a full line of precision thermistors.

What Are Thermistors?

The name is derived from the device's major characteristic – it's a thermally sensitive resistor. There are two major types: NTC, with a negative temperature coefficient of resistance; and PTC, with a positive temperature coefficient. YSI manufactures NTC thermistors, which exhibit a steep drop in resistance as temperature increases, providing high sensitivity to temperature changes. The resistance changes approximately three orders of magnitude in a 100°C range. This provides a means to measure very small temperature variations very accurately.

How We Manufacture Thermistors

Manufacturing precision thermistors involves ceramics technology, solid state chemistry, electronics and precision temperature measurement.

Thermistors are mixed metal oxide semiconductors. We prepare them by intimately mixing fine powders of transition metal oxides, pressing them into disks under high pressure, and firing the disks at high temperature. In the high-temperature firing process, called sintering, the metal oxides undergo a solid state chemical reaction, forming an electrically active material called a spinel. Spinels of transition metal oxides, such as nickel, manganese and iron, exhibit large changes in resistance with small changes in temperature.

After sintering, we apply electrical contacts and attach leads. To protect thermistors from environmental damage, we encapsulate them with epoxy or glass.

The electrical properties are controlled by composition, sintering temperature and oxygen partial pressure. The material constant beta (or slope) and the resistivity (ohm-cm) are established by the manufacturing process. To achieve interchangeability over an extended temperature range, the material constant beta must be tightly controlled. YSI maintains variability in beta of less than 0.3%.

The resistance (ohm) is a function of the resistivity and the physical dimensions of the device. Although the slope and resistivity are fixed by composition and firing temperature, the resistance can be adjusted by varying the dimensions. YSI uses this property in a patented process to manufacture precision interchangeable thermistors.

The Advantages of Thermistors

• **Sensitivity**–A thermistor is much more sensitive to temperature change than other sensors. A typical thermistor changes 1,290 ohms per degree at 25°C.

• **Interchangeability**–YSI thermistors are available with interchangeabilities to ±0.05°C; not just at a single point but over a temperature range from 0 to 70°C. This is a result of precise process control and extreme attention to quality.

• **Two-Wire Connection**–No reference junction compensation necessary as with thermocouples. The thermistor's inherent higher resistance allows for longer lead length without introducing significant errors compared to RTDs, which must operate in a 3-wire or 4-wire mode.

• **Ruggedness**–The NASA qualification program includes numerous tests of ruggedness which YSI thermistors continue to pass. NASA has deemed YSI thermistors worthy of qualification for extended space flight.

• **Hermetic Seal**–YSI glass-encapsulated thermistors achieve a hermetic seal between the environment and the thermistor disk. This permits measurement in severe moisture environments without concern for silver migration.

• **Flexibility**–YSI thermistors come in a great variety of resistances, slope characteristics, lead configurations and encapsulation materials. The charts that follow will help you determine which thermistor will perform best in your application.

YSI Capabilities

This catalog describes YSI thermistors, probes and assemblies for laboratory, medical, industrial and process temperature measurement, control, indication and compensation. You may purchase YSI thermistors unmounted or as complete temperature sensing assemblies.

YSI manufactures thermistors and thermistor probe assemblies for use in diverse fields of temperature sensing: from neonatal infant monitoring to tracking the temperature of astronauts in space; from measurement of temperature in the ocean to maintaining critical temperature parameters of satellites; from one-time use in a disposable medical probe to decades in buried telecommunications cables.

We can provide you with the proper thermistor for the job as well as help you design the appropriate probe configuration for your critical temperature applications.

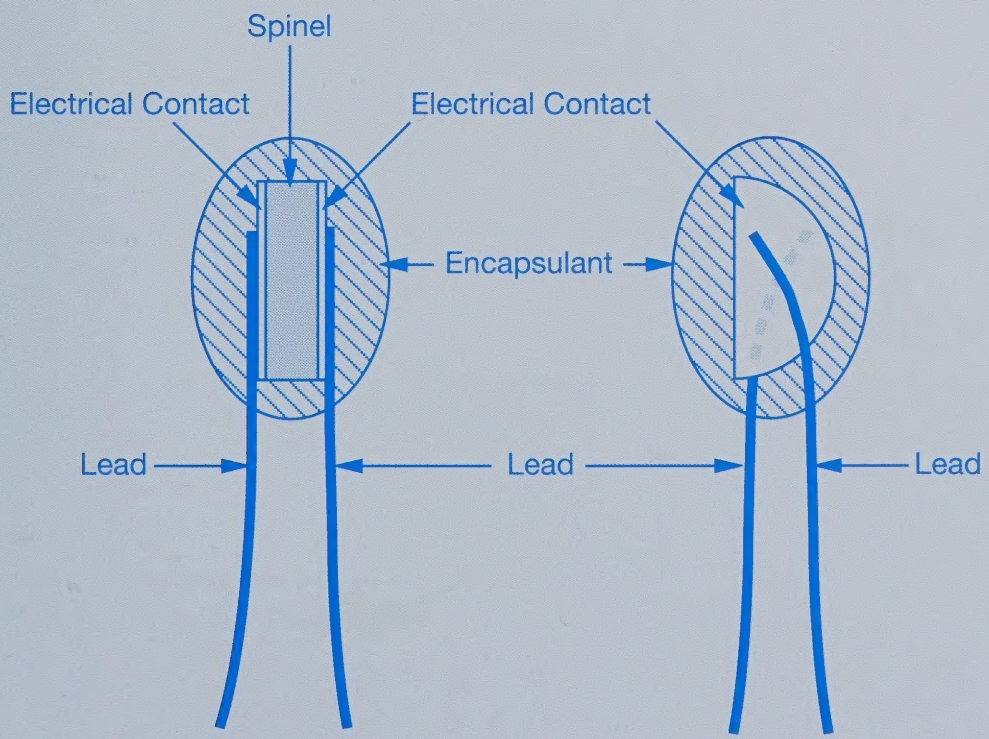
Call us to discuss your application at 800 765-4974. Fax 513 767-9353

• **Special Testing**–We have a special test section for thermistors requiring extraordinary or specific verification of characteristics. Our NASA qualification process includes long-term age testing, burn-in, vibration, impact, humidity, high-temperature and low-temperature exposure.

Our precision temperature measurement capabilities extend past the millikelvin range. The constant-temperature baths we use for verifying thermistor calibration have stabilities and accuracies better than ±5 millikelvin (±0.005°C).

• **NIST Traceability**–Our thermistor temperature measurements are directly traceable to the National Institute of Standards and Technology (NIST). We maintain a world-class temperature calibration laboratory for thermistor reference probes and standard platinum resistance thermometers. It's the only laboratory outside Germany with DKD (Deutscher Kalibrierdienst) accreditation from the PTB, Germany's equivalent of our NIST.

• **SPRTs**–YSI also manufactures the world's working standard of temperature, the traditional standard platinum resistance thermometer (SPRT).



The internal construction of a YSI thermistor

Comparative Sensor Table

We specialize in thermistor-based temperature measurement. The chart tells you how thermistors compare with other temperature measurement methods. When **accuracy** and **sensitivity** are important, thermistors are the best choice.

	Thermistor 100 ohms to 1 megohms at 25°C	Thermocouple B, R, S, E, T, J, K	Platinum 100, 200, 500, 1,000 ohms at 0°C
Sensitivity Units	3.3 to 53K ohms/°C at 25°C	7 to 62 µV/°C	0.00385 and 0.00392 ohms/ohm/°C
Standard Accuracy (°C)			
Interchangeability	±0.05 to ±0.2°C	±0.8 to ±4.4°C	±0.3°C
Stability at 100°C	0.02°C/ month (epoxy) 0.02°C/year (glass)	Depends on environment	0.05°C/year (film) 0.002°C/year (wire)
Power Required	Stable voltage or current	Self-powered	Stable voltage or current
Minimum Practical Span	1°C	100°C	25°C
Temperature Range	-100 to +250°C	-100 to +1750°C	-200 to +750°C
Reference	None	Cold junction	None
Ruggedness	Very rugged	Large wire diameter very rugged	Rugged
Maximum Power (self-heat) for Stated Accuracy	50 µW	NA (susceptible to amplifier bias current error)	500 µW
Sensitivity			
Hysteresis over Range	<0.01°C	>1°C	0.01°C
Repeatability over Range	<0.01°C	±0.5°C	<0.01°C
Lead Wire Configuration	2-wire	Thermocouple or extension wire	2-, 3-, 4-wire

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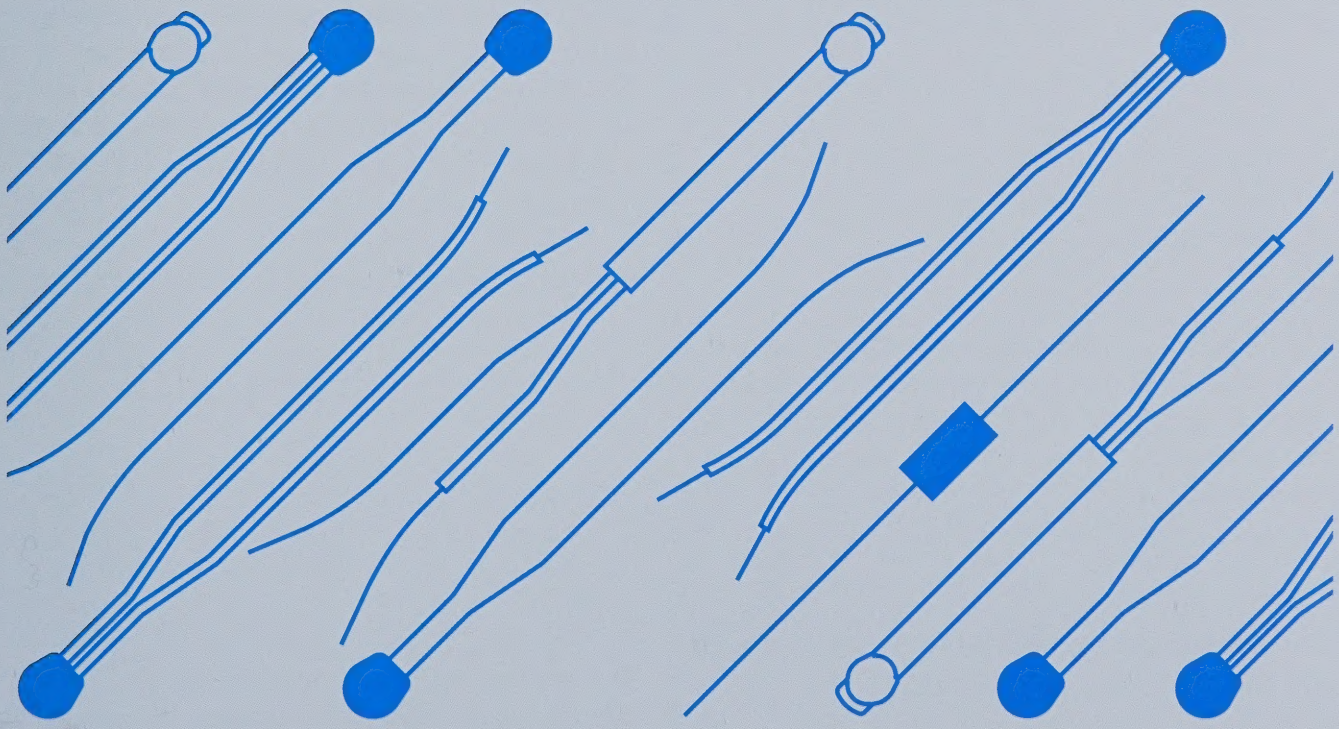
Characteristics of YSI Thermistors

YSI Series	46000	45000	44900	44000	44400	Thermilinear
Coefficient	Negative	Negative	Negative	Negative	Negative	Negative
Resistance Ratio 25°C/125°C	23.51 to 29.26	23.51 to 29.26	23.51 to 29.26	11.49 to 61.96	23.51 to 34.82	NA
Maximum Operating Temperature (°C)	250°C	250°C	150°C	150°C	125°C	150°C
Recommended Operating Range	-80 to +200°C	-80 to +200°C	-80 to +90°C	-80 to + 120°C	-40 to +125°C	-30 to + 100°C
Dissipation Constant	10 mW/°C in oil min 4 mW/°C in air min	10 mW/C in oil min 4 mW/°C in air min	8 mW/°C in oil min 1 mW/°C in air typical	8 mW/°C in oil min 1 mW/°C in air typical	20mW/°C in oil min 8 mW/C in air typical	8 mW/°C in oil min 1 mW/°C in air typical
Thermal Time Constant	2.5 sec max in oil	2.5 sec max in oil	1.0 sec max in oil	1.0 sec max in oil	16 sec max in oil	1.0 sec max in oil
Resistance Available @ 25°C	2252-30K Ω	2252-30K Ω	2252-30K Ω	100 Ω-1 megΩ	10K-100K Ω	NA
Stability	0.01°C/10 mo. @ 100°C 0.05°C/10 mo. @ 150°C	0.05°C/10 mo. @ 100°C 0.11°C/10 mo. @ 150°C	<0.2°C/10 mo. @ 100°C	<0.2°C/10 mo @ 100°C	<0.2°C/10 mo @ 100°C	<0.2°C/10 mo @ 100°C
Interchangeability 0 to 70°C	±0.05, ±0.1 ±0.2°C	±0.2°C	±0.1, ±0.2°C	±0.1, ±0.2°C	±0.2°C	±0.15°C others available
Size	0.125" w x 0.25" l max	0.125" w x 0.25" l max	0.095" w x 0.187" l max	0.095"w x 0.187" l max	0.122" x 0.259" l nom	0.110" w x 0.150" l max
Resistance to Moisture	Hermetic	Hermetic	MIL 23648 90-98% 10 days	90% noncondensing	90% noncondensing	90% noncondensing
Lead Material	Precious metal plated Dumet	Precious metal plated Dumet	Tinned copper	Tinned copper	Tinned annealed copper	Insulated tinned copper

SECTION 1
Thermistor Components



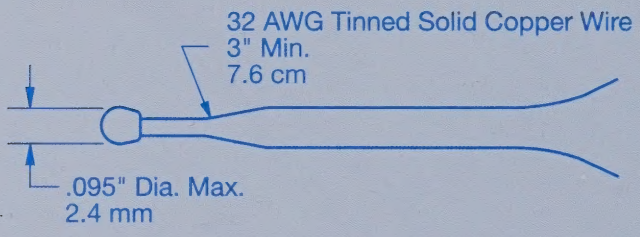
Precision Interchangeable Thermistors

- ***YSI 44000 Series for General Use***
- ***YSI 44100 Series with Teflon Seals for Harsh Environments***
- ***YSI 44400 Series with Axial Leads for Machine Insertion***

YSI thermistors provide highly accurate and stable temperature sensing for measurement, control, indication and compensation. The tight interchangeability of our precision components allows precise measurement without calibration of circuitry to match individual components.

We offer two interchangeability tolerances– ±0.2°C, ±0.1°C – and three configurations – epoxy-covered, Teflon-encapsulated and axial lead machine-insertable thermistors.

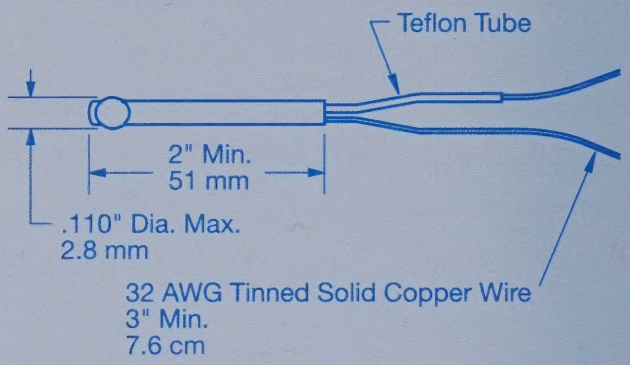
YSI 44000 Series Thermistors



Choose epoxy-covered components for applications where cost, flexibility and a wide range of resistance values are important. The YSI 44000 Series is available in both ±0.2° and ±0.1°C interchangeability tolerances.

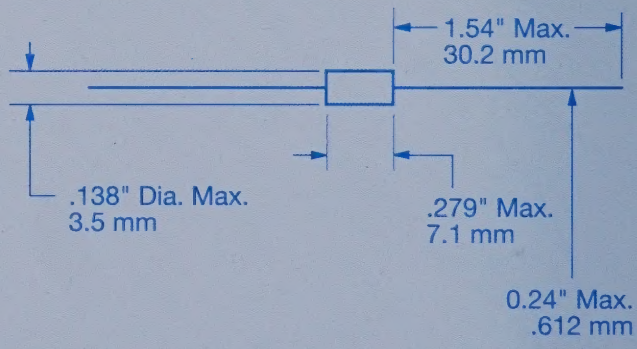
Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 44100 Series Thermistors with Teflon Seals



Teflon-encased thermistors allow exposure to hostile environments such as conductive or corrosive liquids and particulate suspensions. A stiff wire in the tube lets you form the thermistor leads to various shapes with slight finger pressure. We make the YSI 44100 Series in various resistances in ±0.2°C tolerances.

YSI 44400 Series Thermistors with Axial Leads



The tape and reel packaging of our machine-insertable thermistors reduces manufacturing costs and the ±0.2°C interchangeability provides circuit accuracy and reliability. YSI 44400 Series Thermistors are also available in bulk.

On the next page we've listed the basic characteristics of YSI 44000, 44100 and 44400 Series Thermistors.

Specifications

Time Constant: 1 sec max for standard thermistors, 2.5 sec max for Teflon-encased thermistors, when suspended by their leads in a well-stirred oil bath. In still air, 10 sec max for standard thermistors, 25 sec max for Teflon-encased thermistors, 16 sec max for axial lead thermistors.

Dissipation Constant: 8 mW/°C min when suspended by their leads in a well-stirred oil bath, or 1 mW/°C in still air; 1.6 mW/°C for axial lead thermistors in still air.

Stability: YSI thermistors are chemically stable and not significantly affected by aging or exposure to strong nuclear radiation. The table shows typical stability for a representative thermistor, the YSI 44005.

Operating Temperature	Typical Thermometric Drift 10 months	100 months
0°C	<0.01°C	<0.01°C
25°C	<0.01°C	<0.02°C
100°C	0.20°C	0.32°C
150°C	1.5°C	not recommended

Resistance/Temperature Data: A °C resistance versus temperature table is in the Technical Information Section. A °F table is available on request.

Temperature Probe Assemblies: YSI 44000 Series Thermistors may be installed in many of the probes described in the Probe Section.

Maximum Power: 30 mW at 25°C to 1 mW at 125°C short-term.

How to Order

Please order from your YSI representative or YSI Customer Service.

	Ordering Part Numbers			Zero Power Resistance Ω at 25°C	Beta 0-50°C (K)	Ratio Ω 25/125°C	Maximum Working Temperature	Best Storage & Working Temperature	Color Code (Not for MIT) Body	End
	Standard	Teflon	MIT							
±0.2°C Interchangeability Tolerance 0 to 70°C	44001A	44101A	–	100	2854	11.49	100°C	-80-+50°C	black	brown
	44002A	44102A	–	300	3118	15.15	100°C	-80-+50°C	black	red
	44003A	44103A	–	1000	3271	17.33	100°C	-80-+50°C	black	orange
	44035	–	–	100	3271	17.33	100°C	-80-+120°C	orange	green
	44004	44104	–	2252	3891	29.26	150°C	-80-+120°C	black	yellow
	44005	44105	44405	3000	3891	29.26	150°C	-80-+120°C	black	green
	44007	44107	–	5000	3891	29.26	150°C	-80-+120°C	black	violet
	44017	44117	–	6000	3891	29.26	150°C	-80-+120°C	brown	violet
	44016	44116	44416	10K	3891	29.26	150°C	-80-+120°C	brown	blue
	44006	44106	44406	10K	3574	23.51	150°C	-80-+120°C	black	blue
	44008	44108	44408	30K	3810	29.15	150°C	-80-+120°C	black	gray
	44011	44111	44411	100K	3988	34.82	150°C	-80-+120°C	brown	brown
	44014	44114	–	300K	4276	46.02	150°C	-80-+120°C	brown	yellow
	44015	44115	–	1 meg	4582	61.96	150°C	-80-+120°C	brown	green
±0.1°C Interchangeability Tolerance 0 to 70°C	44033	–	–	2252	3891	29.26	75°C	-80-+75°C	orange	orange
	44030	–	–	3000	3891	29.26	75°C	-80-+75°C	orange	black
	44034	–	–	5000	3891	29.26	75°C	-80-+75°C	orange	yellow
	44036	–	–	10K	3891	29.26	75°C	-80-+75°C	orange	blue
	44037	–	–	6K	3891	29.26	75°C	-80-+75°C	orange	violet
	44031	–	–	10K	3574	23.51	75°C	-80-+75°C	orange	brown
	44032	–	–	30K	3810	29.15	75°C	-80-+75°C	orange	red

The tables on pages 10 and 11 show nominal resistance values, ohms per degree (sensitivity), and tolerances in °C and percent, for the full line of YSI 44000 Series Thermistors.

±0.2°C Interchangeability Tolerance

Thermistor	44001A 44101A	44002A 44102A	44003A 44103A	44004 44104	44005 44105	44007 44107	44017 44117	44416 44016 44116	44406 44006 44106	44408 44008 44108	44411 44011 44111	44014 44114	44015 44115
-80°C													
Nom Res	14470	67660	2788K	1660K	2211K	4423K	4423K	7371K	3558K				
Ohms/°	960	4880	20700	142K	189K	315K	379K	63K	262K				
Tol °C	0.60	0.60	0.60	1.00	1.00	1.00	1.00	1.00	1.00				
Tol %	4.10%	4.50%	4.64%	8.60%	8.60%	8.50%	8.60%	8.60%	7.40%				
-40°C													
Nom Res	1374	5198	19640	75790	101K	168300	201900	336500	239800	884600	3356K		
Ohms/°	69	284.5	1115	5045	6710	11250	13450	22400	14200	53700	209K		
Tol °C	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40		
Tol %	2.01%	2.19%	2.28%	2.66%	2.66%	2.66%	2.66%	2.66%	2.37%	2.50%	2.49%		
0°C													
Nom Res	239.2	777.5	2710	7355	9796	16330	19600	32660	29490	94980	333100	1088K	3966K
Ohms/°	9.1	32.05	117	376	500	835	1K	1670	1370	4695	17150	58K	226K
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.76%	0.83%	0.86%	1.02%	1.02%	1.02%	1.02%	1.02%	0.93%	1.00%	1.03%	1.10%	1.17%
25°C													
Nom Res	100	300	1K	2252	3K	5K	6K	10K	10K	30K	100K	300K	1000K
Ohms/°	3.2	10.55	37.05	99	131.5	219	264	438	402.5	1290	4495	14500	51650
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.64%	0.70%	0.74%	0.88%	0.88%	0.88%	0.88%	0.88%	0.81%	0.86%	0.90%	0.97%	1.03%
40°C													
Nom Res	63.1	181.4	589.5	1200	1598	2663	3197	5329	5592	16150	52190	149400	473200
Ohms/°	1.85	5.8	19.85	48.5	64.5	107	129.5	215	208	640	2175	6700	22800
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.61%	0.64%	0.67%	0.80%	0.80%	0.80%	0.80%	0.80%	0.74%	0.80%	0.83%	0.90%	0.96%
70°C													
Nom Res	28.3	75.2	233	394.5	525.4	875.7	1051	1752	1990	5359	16370	42850	123300
Ohms/°	0.7	2	6.6	13.5	17.95	29.95	36	60	63.5	182.5	585	1655	5150
Tol °C	0.36	0.36	0.36	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.88%	0.96%	1.02%	0.68%	0.68%	0.68%	0.68%	0.68%	0.64%	0.68%	0.71%	0.77%	0.84%
100°C													
Nom Res	14.3	35.8	106.4	152.8	203.8	339.6	407.1	678.5	816.8	2069	6005	14480	38200
Ohms/°	0.3	0.9	2.6	4.45	5.95	9.95	11.85	19.75	22.55	61	187	490	1380
Tol °C	1.00	1.00	1.00	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Tol %	2.09%	2.26%	2.41%	0.88%	0.88%	0.88%	0.88%	0.88%	0.83%	0.88%	0.93%	1.02%	1.09%
150°C													
Nom Res				41.9	55.6	92.7	111.6	186.1	237	550.2	1481	3186	7447
Ohms/°				0.9	1.3	2.17	2.4	4	5.3	13.3	38	88	222
Tol °C				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tol %				2.30%	2.33%	2.30%	2.30%	2.30%	2.22%	2.35%	2.57%	2.71%	2.93%

±0.1°C Interchangeability Tolerance

Thermistor	44033	44030	44034	44037	44036	44031	44032
-80°C							
Nom Res	1660K	2211K	4423K	4423K	7371K	3558K	
Ohms/°	142K	189K	315K	379K	630K	262K	
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	
Tol %	8.60%	8.60%	8.50%	8.60%	8.60%	7.40%	
-40°C							
Nom Res	75790	101K	168300	201900	336500	239800	884600
Ohms/°	5045	6710	11250	13450	22400	14200	53700
Tol °C	0.20	0.20	0.20	0.20	0.20	0.40	0.20
Tol %	1.33%	1.33%	1.33%	1.33%	2.66%	2.37%	1.25%
0°C							
Nom Res	7355	9796	16330	19600	32660	29490	94980
Ohms/°	376	500	835	1K	1670	1370	4695
Tol °C	0.10	0.10	0.10	0.10	0.10	0.12	0.10
Tol %	0.51%	0.51%	0.51%	0.51%	0.51%	0.56%	0.50%
25°C							
Nom Res	2252	3K	5K	6K	10K	10K	30K
Ohms/°	99	131.5	219	264	438	402.5	1290
Tol °C	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Tol %	0.44%	0.44%	0.44%	0.44%	0.44%	0.40%	0.40%
40°C							
Nom Res	1200	1598	2663	3197	5329	5592	16150
Ohms/°	48.5	64.5	107	129.5	215	208	640
Tol °C	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Tol %	0.40%	0.40%	0.40%	0.40%	0.40%	0.37%	0.40%
70°C							
Nom Res	394.5	525.4	875.7	1051	1752	1990	5359
Ohms/°	13.5	17.95	29.95	36	60	63.5	182.5
Tol °C	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Tol %	0.34%	0.34%	0.34%	0.34%	0.34%	0.32%	0.34%
100°C							
Nom Res	152.8	203.8	339.6	407.1	678.5	816.8	2069
Ohms/°	4.45	5.95	9.95	11.85	19.75	22.55	61
Tol°C	0.15	0.15	0.15	0.15	0.15	0.30	0.15
Tol %	0.44%	0.44%	0.44%	0.44%	0.83%	0.44%	
150°C							
Nom Res	41.9	55.6	92.7	111.6	186.1	237	550.2
Ohms/°	0.9	1.3	2.17	2.4	4	5.3	13.3
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tol %	2.30%	2.33%	2.30%	2.30%	2.30%	2.22%	2.35%

High-Temperature Hermetic Thermistors

• *YSI 45000 Series*

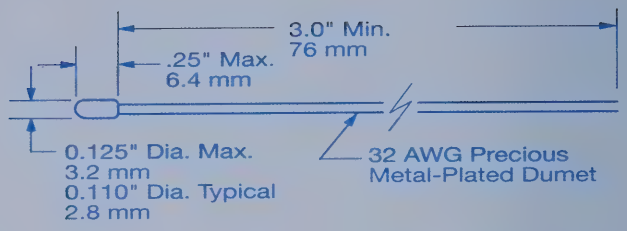
YSI 45000 Series Thermistors are manufactured with glass hermetic encapsulation, providing stability over a wide range of operating temperatures. We've designed this series for elevated temperatures or for high humidity (95% or above). You may substitute these thermistors for the YSI 44000 Series with no circuit changes.

Replacement of the standard epoxy coating with glass hermetic encapsulation provides significant advantages.

- Improved resistance to humid environments
- Excellent high-temperature stability
- Interchangeability at high temperature
- Wide operating range: -80 to +250°C
- Higher power handling capabilities

YSI 45000 Series thermistors come in a range of resistance values, and ±0.2°C interchangeability tolerance. For further information on glass thermistor performance in severe moisture environments, see page 14, Tests Show Thermistor Stability.

Call us to discuss your application at 800 765-4974. Fax 513 767-9353



Specifications

Time Constant: 2.5 sec max when suspended by its leads in a well-stirred oil bath.

Dissipation Constant: 10 mW/°C min when suspended by its leads in a well-stirred oil bath, or 4 mW/°C in still air.

Stability: Typical thermistor stability at 100°C is 0.05°C for 10 months.

Resistance/Temperature Data: A °C resistance versus temperature table is in the Technical Information Section. A °F table is available on request.

Temperature Probe Assemblies: YSI 45000 Series Thermistors may be installed in many of the probes described in the Probe Section.

Maximum Power: 50 mW at 25°C derated to 2 mW at 125°C.

How to Order

Please order from your YSI representative or YSI Customer Service.

	Ordering Part Numbers	Zero Power Resistance Ω at 25°C	Beta 0 to 50°C β (K)	Ratio Ω 25/125°C	Maximum Working Temperature
±0.2°C Interchangeability Tolerance 0 to 70°C	45004	2252	3891	29.26	200°C
	45005	3000	3891	29.26	200°C
	45007	5000	3891	29.26	250°C
	45017	6K	3891	29.26	250°C
	45006	10K	3574	23.51	250°C
	45016	10K	3891	29.26	250°C
	45008	30K	3810	29.15	250°C

±0.2°C Interchangeability Tolerance

Thermistor	45004	45005	45007	45017	45016	45006	45008
-80°C							
Nom Res	1660K	2211K	4423K	4423K	7371K	3558K	
Ohms/°	142K	189K	315K	379K	630K	262K	
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	
Tol %	8.60%	8.60%	8.50%	8.60%	8.60%	7.40%	
-40°C							
Nom Res	75790	101K	168.3K	201.9K	336.5K	239.8K	884.6K
Ohms/°	5045	6710	11250	13450	22400	14200	53700
Tol °C	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Tol %	2.66%	2.66%	2.66%	2.66%	2.66%	2.37%	2.50%
0°C							
Nom Res	7355	9796	16330	19600	32660	29490	94980
Ohms/°	376	500	835	1000	1670	1370	4695
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	1.02%	1.02%	1.02%	1.02%	1.02%	0.93%	1.00%
25°C							
Nom Res	2252	3K	5K	6K	10K	10K	30K
Ohms/°	99	131.5	219	264	438	402.5	1290
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.88%	0.88%	0.88%	0.88%	0.88%	0.81%	0.86%
40°C							
Nom Res	1200	1598	2663	3197	5329	5592	16150
Ohms/°	48.5	64.5	107	129.5	215	208	640
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.80%	0.80%	0.80%	0.80%	0.80%	0.74%	0.80%
70°C							
Nom Res	394.5	525.4	875.7	1051	1752	1990	5359
Ohms/°	13.5	17.95	29.95	36	60	63.5	182.5
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.68%	0.68%	0.68%	0.68%	0.68%	0.64%	0.68%
100°C							
Nom Res	152.8	203.8	339.6	407.1	678.5	816.8	2069
Ohms/°	4.45	5.95	9.95	11.85	19.75	22.55	61
Tol °C	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Tol %	0.88%	0.88%	0.88%	0.88%	0.88%	0.83%	0.88%
150°C							
Nom Res	41.9	55.6	92.7	111.6	186.1	237	550.2
Ohms/°	0.9	1.3	2.17	2.4	4	5.3	13.3
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tol %	2.30%	2.33%	2.30%	2.30%	2.30%	2.22%	2.35%
200°C							
Nom Res	14.9	19.8	32.9	39.6	65.9	86.5	186.7
Ohms/°	0.25	0.40	0.60	0.70	1.20	1.55	3.65
Tol °C	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Tol %	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%
250°C							
Nom Res			14.2	17.1	28.5	37.5	75.3
Ohms/°			0.22	0.26	0.43	0.57	1.26
Tol °C			1.75	1.75	1.75	1.75	1.75
Tol %			2.80%	2.80%	2.80%	2.61%	2.80%

See page 14, Tests Show Thermistor Stability, for information on using YSI 45000 Series Thermistors in severe environments.

Super-Stable Thermistors

• YSI 46000 Series

YSI 46000 Series components represent the state of the art in long-term stability performance. By coupling glass hermetic encapsulation with 100% resistance shift screening, we offer stability never before realized with thermistor components.

We offer YSI 46000 Series thermistors with interchangeability tolerances as tight as ±0.05°C, as well as ±0.1°C and ±0.2°C.

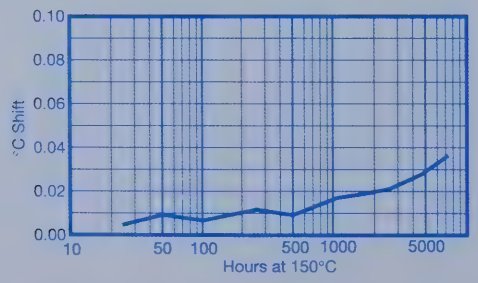
Many leading aerospace companies have recognized the advantages of these parts, developing their own specifications for qualifying, screening and using these thermistors in high-reliability applications. We welcome your inquiry on special measurement points or screening testing.

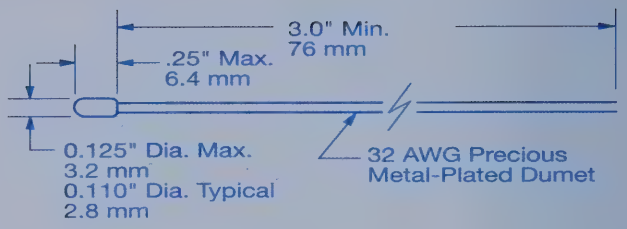
• Tests Show Thermistor Stability

YSI 45000 and 46000 Series Thermistors offer unparalleled stability and moisture resistance in thermistor components. The data from the three tests we performed demonstrate that YSI glass thermistors are the device of choice in extreme environments.

High-Temperature Testing

The first was static high-temperature testing. All thermistors show some increase in resistance over time; the higher the temperature the greater the shift. We placed YSI glass thermistors in an isothermal 150°C environment for extended time testing. On average, they shifted less than 0.040°C in 5,000 hours.





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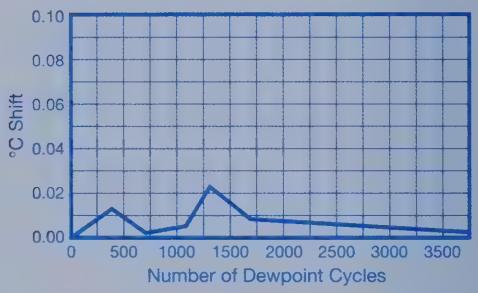
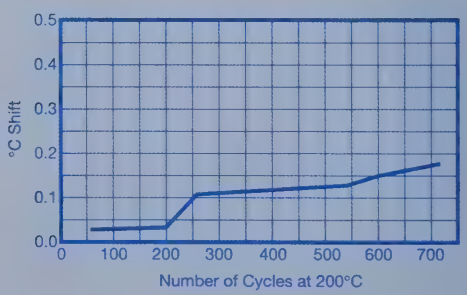
Differential Dew Point Cycling

The second test was cycling from ambient to below the dew point. Moisture is a major cause of failure in standard non-hermetic thermistors. This test exposed the thermistors to multiple cycles with 11 minutes below the dew point and 11 minutes at ambient. After over 3,500 cycles, we saw no appreciable shifts.



High-Temperature Cycling

The last, and most rigorous test, was thermal cycling. This cycle consisted of 11 minutes at ambient and 11 minutes at 200°C. We ran several hundred cycles. Shifts after 700 cycles averaged less than 0.2°C.



Specifications

Time Constant: 2.5 sec max when suspended by its leads in a well-stirred oil bath.

Dissipation Constant: 10 mW/°C min when suspended by its leads in a well-stirred oil bath, or 4 mW/°C in still air.

Resistance/Temperature Data: A °C resistance versus temperature table is in the Technical Information Section. A °F table is available on request.

Temperature Probe Assemblies: YSI 46000 Series Thermistors may be installed in many of the probes described in the Probe Section.

Typical Thermometric Drift

Operating Temperature	Typical Thermometric Drift 10 months	100 months
25°C	<0.01°C	<0.01°C
70°C	<0.01°C	<0.01°C
100°C	0.02°C	0.03°C
150°C	0.05°C	0.08°C
200°C	0.22°C	0.60°C

How to Order

Please order from your YSI representative or YSI Customer Service.

	Ordering Part Numbers	Zero Power Resistance Ω at 25°C	Beta 0 to 50°C β (K)	Ratio Ω 25 /125°C	Maximum Working Temperature
±0.2°C Interchangeability Tolerance 0 to 70°C	46004	2252	3891	29.26	200°C
	46005	3000	3891	29.26	200°C
	46007	5000	3891	29.26	200°C
	46017	6K	3891	29.26	200°C
	46006	10K	3574	23.51	200°C
	46016	10K	3891	29.26	200°C
	46008	30K	3810	29.15	200°C
±0.1°C Interchangeability Tolerance 0 to 70°C	46033	2252	3891	29.26	200°C
	46030	3000	3891	29.26	200°C
	46034	5000	3891	29.26	200°C
	46037	6K	3891	29.26	200°C
	46031	10K	3574	23.51	200°C
	46036	10K	3891	29.26	200°C
	46032	30K	3810	29.15	200°C
±0.05°C Interchangeability Tolerance 0 to 70°C	46043	2252	3891	29.26	200°C
	46040	3000	3891	29.26	200°C
	46044	5000	3891	29.26	200°C
	46047	6000	3891	29.26	200°C
	46041	10K	3574	23.51	200°C
	46046	10K	3891	29.26	200°C

±0.2°C Interchangeability Tolerance

Thermistor	46004	46005	46007	46017	46016	46006	46008
-80°C							
Nom Res	1660K	2211K	4423K	4423K	7371K	3558K	
Ohms/°	142K	189K	315K	379K	630K	262K	
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	
Tol %	8.60%	8.60%	8.50%	8.60%	8.60%	7.40%	
-40°C							
Nom Res	75790	101K	168.3K	201.9K	336.5K	239.8K	884.6K
Ohms/°	5045	6710	11250	13450	22400	14200	53700
Tol °C	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Tol %	2.66%	2.66%	2.66%	2.66%	2.66%	2.37%	2.50%
0°C							
Nom Res	7355	9796	16330	19600	32660	29490	94980
Ohms/°	376	500	835	1000	1670	1370	4695
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	1.02%	1.02%	1.02%	1.02%	1.02%	0.93%	1.00%
25°C							
Nom Res	2252	3K	5K	6K	10K	10K	30K
Ohms/°	99	131.5	219	264	438	402.5	1290
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.88%	0.88%	0.88%	0.88%	0.88%	0.81%	0.86%
40°C							
Nom Res	1200	1598	2663	3197	5329	5592	16150
Ohms/°	48.5	64.5	107	129.5	215	208	640
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.80%	0.80%	0.80%	0.80%	0.80%	0.74%	0.80%
70°C							
Nom Res	394.5	525.4	875.7	1051	1752	1990	5359
Ohms/°	13.5	17.95	29.95	36	60	63.5	182.5
Tol °C	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Tol %	0.68%	0.68%	0.68%	0.68%	0.68%	0.64%	0.68%
100°C							
Nom Res	152.8	203.8	339.6	407.1	678.5	816.8	2069
Ohms/°	4.45	5.95	9.95	11.85	19.75	22.55	61
Tol °C	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Tol %	0.88%	0.88%	0.88%	0.88%	0.88%	0.83%	0.88%
150°C							
Nom Res	41.9	55.6	92.7	111.6	186.1	237	550.2
Ohms/°	0.9	1.3	2.17	2.4	4	5.3	13.3
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tol %	2.30%	2.33%	2.30%	2.30%	2.30%	2.22%	2.35%
200°C							
Nom Res	14.9	19.8	32.9	39.6	65.9	86.5	186.7
Ohms/°	0.25	0.40	0.60	0.70	1.20	1.55	3.65
Tol °C	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Tol %	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%

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±0.1°C Interchangeability Tolerance

Thermistor	46033	46030	46034	46037	46036	46031	46032
-80°C							
Nom Res	1660K	2211K	4423K	4423K	7371K	3558K	
Ohms/°	142K	189K	315K	379K	630K	262K	
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	
Tol %	8.60%	8.60%	8.50%	8.60%	8.60%	7.40%	
-40°C							
Nom Res	75790	101K	168.3K	201.9K	336.5K	239.8K	884.6K
Ohms/°	5045	6710	11250	13450	22400	14200	53700
Tol °C	0.20	0.20	0.20	0.20	0.20	0.40	0.20
Tol %	1.33%	1.33%	1.33%	1.33%	1.33%	2.37%	1.25%
0°C							
Nom Res	7355	9796	16330	19600	32660	29490	94980
Ohms/°	376	500	835	1000	1670	1370	4695
Tol °C	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Tol %	0.51%	0.51%	0.51%	0.51%	0.51%	0.46%	0.50%
25°C							
Nom Res	2252	3000	5000	6000	10K	10K	30K
Ohms/°	99	131.5	219	264	438	402.5	1290
Tol °C	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Tol %	0.44%	0.44%	0.44%	0.44%	0.44%	0.41%	0.43%
40°C							
Nom Res	1200	1598	2663	3197	5329	5592	16150
Ohms/°	48.5	64.5	107	129.5	215	208	640
Tol °C	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Tol %	0.40%	0.40%	0.40%	0.40%	0.40%	0.37%	0.40%
70°C							
Nom Res	394.5	525.4	875.7	1051	1752	1990	5359
Ohms/°	13.5	17.95	29.95	36	60	63.5	182.5
Tol °C	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Tol %	0.34%	0.34%	0.34%	0.34%	0.34%	0.32%	0.34%
100°C							
Nom Res	152.8	203.8	339.6	407.1	678.5	816.8	2069
Ohms/°	4.45	5.95	9.95	11.85	19.75	22.55	61
Tol °C	0.15	0.15	0.15	0.15	0.15	0.30	0.15
Tol %	0.44%	0.44%	0.44%	0.44%	0.44%	0.83%	0.44%
150°C							
Nom Res	41.9	55.6	92.7	111.6	186.1	237	550.2
Ohms/°	0.9	1.3	2.17	2.4	4	5.3	13.3
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tol %	2.30%	2.33%	2.30%	2.30%	2.30%	2.22%	2.35%
200°C							
Nom Res	14.9	19.8	32.9	39.6	65.9	86.5	186.7
Ohms/°	0.25	0.40	0.60	0.70	1.20	1.55	3.65
Tol °C	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Tol %	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%

±0.05°C Interchangeability Tolerance

Thermistor	46043	46040	46044	46047	46046	46041
-80°C						
Nom Res	1660K	2211K	4423K	4423K	7371K	3558K
Ohms/°	142K	189K	315K	379K	630K	262K
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00
Tol %	8.60%	8.60%	8.50%	8.60%	8.60%	7.40%
-40°C						
Nom Res	75790	101K	168.3K	201.9K	336.5K	239.8K
Ohms/°	5045	6710	11250	13450	22400	14200
Tol °C	0.20	0.20	0.20	0.20	0.20	0.40
Tol %	1.33%	1.33%	1.33%	1.33%	1.33%	2.37%
0°C						
Nom Res	7355	9796	16.33K	19.6K	32.66K	29.49K
Ohms/°	376	500	835	1000	1670	1370
Tol °C	0.05	0.05	0.05	0.05	0.05	0.05
Tol %	0.26%	0.26%	0.26%	0.26%	0.26%	0.23%
25°C						
Nom Res	2252	3K	5K	6K	10K	10K
Ohms/°	99	131.5	219	264	438	402.5
Tol °C	0.05	0.05	0.05	0.05	0.05	0.05
Tol %	0.22%	0.22%	0.22%	0.22%	0.22%	0.21%
40°C						
Nom Res	1200	1598	2663	3197	5329	5592
Ohms/°	48.5	64.5	107	129.5	215	208
Tol °C	0.05	0.05	0.05	0.05	0.05	0.05
Tol %	0.20%	0.20%	0.20%	0.20%	0.20%	0.18%
70°C						
Nom Res	394.5	525.4	875.7	1051	1752	1990
Ohms/°	13.5	17.95	29.95	36	60	63.5
Tol °C	0.05	0.05	0.05	0.05	0.05	0.05
Tol %	0.17%	0.17%	0.17%	0.17%	0.17%	0.16%
100°C						
Nom Res	152.8	203.8	339.6	407.1	678.5	816.8
Ohms/°	4.45	5.95	9.95	11.85	19.75	22.55
Tol °C	0.15	0.15	0.15	0.15	0.15	0.30
Tol %	0.44%	0.44%	0.44%	0.44%	0.44%	0.83%
150°C						
Nom Res	41.9	55.6	92.7	111.6	186.1	237
Ohms/°	0.9	1.3	2.17	2.4	4	5.3
Tol °C	1.00	1.00	1.00	1.00	1.00	1.00
Tol %	2.30%	2.33%	2.30%	2.30%	2.30%	2.22%
200°C						
Nom Res	14.9	19.8	32.9	39.6	65.9	86.5
Ohms/°	0.25	0.40	0.60	0.70	1.20	1.55
Tol °C	1.30	1.30	1.30	1.30	1.30	1.30
Tol %	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%

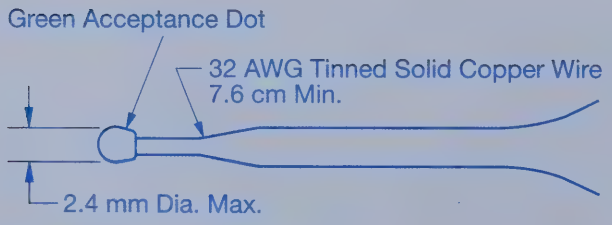
NASA Space-Qualified Thermistors

- ***YSI 44900 Series***
- ***Goddard Space Flight Center GSFC S-311-P-18***

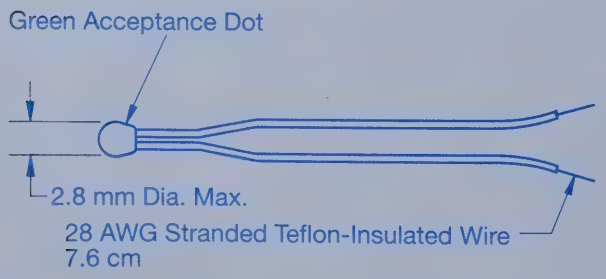
NASA has qualified YSI epoxy-encapsulated thermistors for use in extended space flight. The Goddard Space Flight Center issued GSFC S-311-P-18 in 1974 to specify the performance requirements for these thermistors. We re-qualify a group of thermistors every year and screen every thermistor before stocking.

Re-qualification includes the following tests that are referenced in MIL T-23648.

- Short time load
- Thermal shock
- Insulation resistance
- Resistance to soldering heat
- Low-temperature storage
- High-temperature storage
- Dissipation constant
- Thermal time constant
- Terminal strength
- Moisture resistance
- High-temperature exposure
- High-frequency vibration
- Medium-impact shock
- Immersion



Type S Lead Configuration



Type T Lead Configuration

We screen every 44900 Series Thermistor according to this specification. Screening includes visual and mechanical requirements, thermal shock, high-temperature storage, insulation resistance and additional resistance versus temperature analysis.

This qualification and screening gives you confidence that the component will perform to the rigorous requirements of space flight or other application. Customers often submit their own specifications that use our testing capabilities in combinations not in the Goddard specification.

Thermistors procured in compliance with GSFC-311-P-18 are identified by a specific Goddard part number with a 311P18 prefix, a dash number for resistance and range, a lead code and a lead length code. We stock components with S style leads 7.6 cm long. Please contact YSI Customer Service when ordering other lead styles or lengths.

Specifications

Standard Configuration: YSI 44900 Series Thermistors are provided to the specifications shown on the drawings. Each unit is color-coded to indicate resistance value and marked with a green dot between the leads to indicate successful acceptance testing.

Configuration Options: On special order, YSI 44900 Series Thermistors are available with a wide variety of options, including leads of various lengths, special lead materials, insulated leads and as fully-encased units. Space-qualified thermistors also may be installed in many of the probes described in the Probe Section.

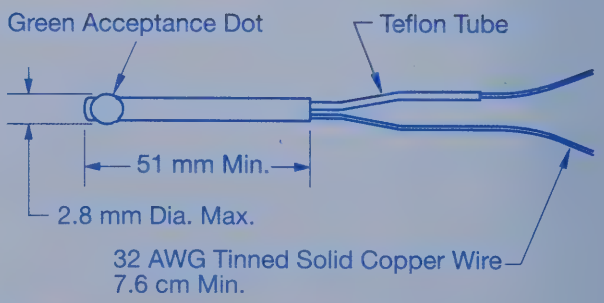
Time Constant: 1 sec max when suspended by its leads in a well-stirred oil bath.

Dissipation Constant: 8 mW/°C min when suspended by its leads in a well-stirred oil bath, or 1 mW/°C in still air.

Resistance/Temperature Data: A °C resistance versus temperature table is in the Technical Information Section. A °F table is available on request.

How to Order

Please order from your YSI representative or YSI Customer Service.



Type E Lead Configuration

±0.2°C Interchangeability Tolerance

Thermistor	44901	44903	44905	44907	44909
	44004	44005	44007	44006	44008
-80°C					
Nom Res	1660K	2211K	4423K	3558K	
Ohms/°	142000	189000	315000	262000	
Tol °C	1.00	1.00	1.00	1.00	
Tol %	8.60%	8.60%	8.50%	7.40%	
-40°C					
Nom Res	75790	101K	168.3K	239.8K	884.6K
Ohms/°	5045	6710	11250	14200	53700
Tol °C	0.40	0.40	0.40	0.40	0.40
Tol %	2.66%	2.66%	2.66%	2.37%	2.50%
0°C					
Nom Res	7355	9796	16330	29490	94980
Ohms/°	376	500	835	1370	4695
Tol %	1.02%	1.02%	1.02%	0.93%	1.00%
25°C					
Nom Res	2252	3K	5K	10K	30K
Ohms/°	99	131.5	219	402.5	1290
Tol °C	0.20	0.20	0.20	0.20	0.20
Tol %	0.88%	0.88%	0.88%	0.81%	0.86%
40°C					
Nom Res	1200	1598	2663	5592	16150
Ohms/°	48.5	64.5	107	208	640
Tol °C	0.20	0.20	0.20	0.20	0.20
Tol %	0.80%	0.80%	0.80%	0.74%	0.80%
70°C					
Nom Res	394.5	525.4	875.7	1990	5359
Ohms/°	13.5	17.95	29.95	63.5	182.5
Tol°C	0.20	0.20	0.20	0.20	0.20
Tol %	0.68%	0.68%	0.68%	0.64%	0.68%
100°C					
Nom Res	152.8	203.8	339.6	816.8	2069
Ohms/°	4.45	5.95	9.95	22.55	61
Tol °C	0.30	0.30	0.30	0.30	0.30
Tol %	0.88%	0.88%	0.88%	0.83%	0.88%
150°C					
Nom Res	41.9	55.6	92.7	237	550.2
Ohms/°	0.9	1.3	2.17	5.3	13.3
Tol °C	1.00	1.00	1.00	1.00	1.00
Tol %	2.30%	2.30%	2.30%	2.22%	2.35%

±0.1°C Interchangeability Tolerance

Thermistor	44902	44904	44906	44908	44910
	44033	44030	44034	44031	44032
-80°C					
Nom Res	1660K	2211K	4423K	3558K	
Ohms/°	142K	189K	315K	262K	
Tol °C	1.00	1.00	1.00	1.00	
Tol %	8.60%	8.60%	8.50%	7.40%	
-40°C					
Nom Res	75790	101K	168.3K	239.8K	884.6K
Ohms/°	5045	6710	11250	14200	53700
Tol °C	0.20	0.20	0.20	0.40	0.20
Tol %	1.33%	1.33%	1.33%	2.37%	1.25%
0°C					
Nom Res	7355	9796	16330	29490	94980
Ohms/°	376	500	835	1370	4695
Tol °C	0.10	0.10	0.10	0.12	0.10
Tol %	0.51%	0.51%	0.51%	0.56%	0.50%
25°C					
Nom Res	2252	3K	5K	10K	30K
Ohms/°	99	131.5	219	402.5	1290
Tol °C	0.10	0.10	0.10	0.10	0.10
Tol %	0.44%	0.44%	0.44%	0.40%	0.40%
40°C					
Nom Res	1200	1598	2663	5592	16150
Ohms/°	48.5	64.5	107	208	640
Tol °C	0.10	0.10	0.10	0.10	0.10
Tol %	0.40%	0.40%	0.40%	0.37%	0.40%
70°C					
Nom Res	394.5	525.4	875.7	1990	5359
Ohms/°	13.5	17.95	29.95	63.5	182.5
Tol°C	0.10	0.10	0.10	0.10	0.10
Tol %	0.34%	0.34%	0.34%	0.32%	0.34%
100°C					
Nom Res	152.8	203.8	339.6	816.8	2069
Ohms/°	4.45	5.95	9.95	22.55	61
Tol °C	0.15	0.15	0.15	0.30	0.15
Tol %	0.44%	0.44%	0.44%	0.83%	0.44%
150°C					
Nom Res	41.9	55.6	92.7	237	550.2
Ohms/°	0.9	1.3	2.17	5.3	13.3
Tol °C	1.00	1.00	1.00	1.00	1.00
Tol %	2.30%	2.30%	2.30%	2.22%	2.35%

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	Ordering Part Number	GSFC S311P18 Number	Basic YSI Thermistor	Zero Power Resistance Ω at 25°C	Beta 0-50°C (K)	Operating & Storage Temperature*	Color Code Body	End
±0.2°C Interchangeability Tolerance 0 to 75°C	44901	-01S7R6	44004	2252	3891	-55-+90°C	black	yellow
	44903	-03S7R6	44005	3000	3891	-55-+90°C	black	green
	44905	-05S7R6	44007	5000	3891	-55-+90°C	black	violet
	44907	-07S7R6	44006	10K	3574	-55-+90°C	black	blue
	44909	-09S7R6	44008	30K	3810	-55-+90°C	black	gray
±0.1°C Interchangeability Tolerance 0 to 75°C	44902	-02S7R6	44033	2252	3891	-55-+70°C	orange	orange
	44904	-04S7R6	44030	3000	3891	-55-+70°C	orange	black
	44906	-06S7R6	44034	5000	3891	-55-+70°C	orange	yellow
	44908	-08S7R6	44031	10K	3574	-55-+70°C	orange	brown
	44910	-10S7R6	44032	30K	3810	-55-+70°C	orange	red

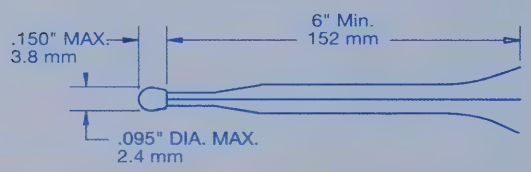
*Thermistors with ±1.0% resistance tolerance may have short-term operating temperature excursions to 150°C; thermistors with ±0.5% resistance tolerance may have short-term operating temperature excursions to 100°C.

YSI Thermilinear Components

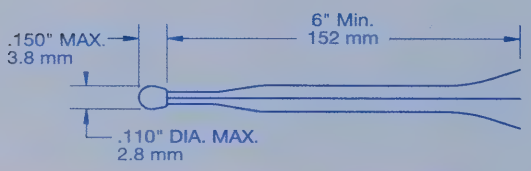
Temperature measurement, control and compensation applications requiring linear electrical response to temperature changes are easily handled by YSI Thermilinear Components. Each Thermilinear Network consists of two sub-components – a thermistor component and a resistor set.

The active element is the thermistor component, made from two YSI precision thermistors with three leads, epoxy encapsulated, to form the YSI 44018 and 44019A sensors; and three thermistors with four leads to form the YSI 44020 sensor.

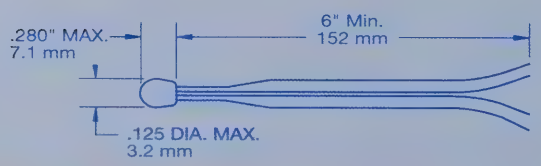
The resistor set consists of two precision metal film resistors for use with the YSI 44018 and 44019A thermistor composites, and three resistors for use with the YSI 44020 thermistor composite.



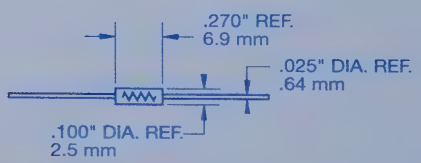
YSI 44018 Thermilinear Component



YSI 44019A Thermilinear Component



YSI 44020 Thermilinear Component



YSI 44300 Series Resistor

The combination of thermistor component and resistor set is called a Thermilinear Network. For example, a YSI 44018 thermistor component plus a YSI 44301 resistor set become a YSI 44201 Thermilinear Network. The Thermilinear Network may be used as a device for linear voltage versus temperature or linear resistance versus temperature.

Sensitivity is 400 times greater than a thermocouple, with outputs as high as 30 mV/°C. Output voltage applied to a recorder or digital voltmeter will produce a precise, sensitive, direct-reading thermometer.

How to Use YSI Thermilinear Networks

To understand how a Thermilinear Network functions, first consider what happens when a single thermistor is shunted with a fixed resistor.

As shown in the R versus T charts, the thermistor has an approximately logarithmic, negative temperature characteristic. To make the R/T characteristic more nearly linear, the rate of resistance change must decrease as the temperature decreases. A single shunt resistor will do this.

If this shunt combination is supplied with a constant current, the voltage change across the combination will be linear with resistance change and temperature.

These two components can be reconnected with the resistor in series with the thermistor to form a voltage divider (half bridge) which, when connected across a constant voltage source, will yield a linear output voltage versus temperature across either the resistor or thermistor.

These circuits, although useful because of their simplicity, are restricted to very narrow temperature ranges, usually 25°C or less. As the range is extended, the fixed resistor will be too large at the high temperature end and too small at the low temperature end.

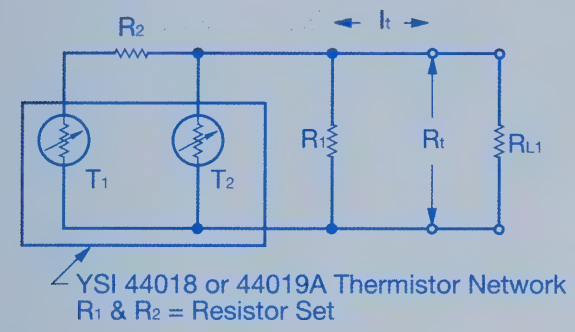
The solution is to add one or more thermistors to the circuit to compensate the first linearizing resistor already in the network.

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

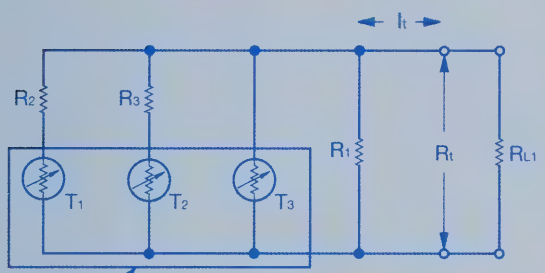
General Theory

Resistance Mode

Resistance mode operation is achieved by configuring the components as shown in the figures below.



YSI 44018 or 44019A Thermistor Network
R_1 & R_2 = Resistor Set



YSI 44020 Thermistor Network
R_1, R_2 & R_3 = Resistor Set

Different networks may be created by changing resistor values. Each Thermilinear network has a unique resistance versus temperature relationship. This relationship is defined by the formula:

$$R_t = mX + b$$

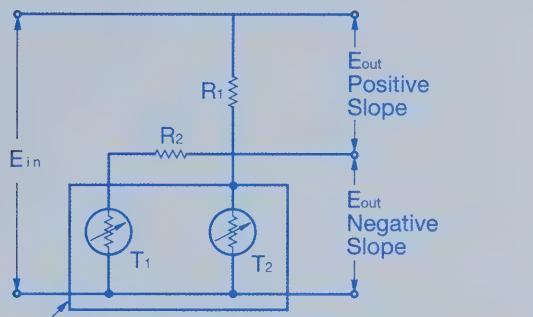
Where: R_t = total circuit resistance
m = change in resistance per degree (slope)
X = temperature in degrees
b = resistance at 0° (0°offset or intercept)

The slope and intercept values for standard networks are on the following pages. Non-standard range values are in the Technical Information Section.

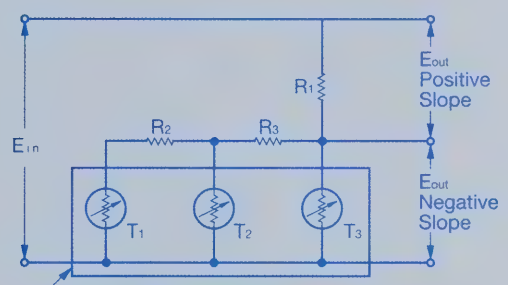
Variation from this calculated value by actual thermistor network values is defined as the linearity deviation. The lower the linearity deviation, the more closely the actual network values track the calculated values.

Voltage Mode

Voltage mode operation is achieved by configuring the components as shown in the figures below.



YSI 44018 or YSI 44019 Thermistor Network
R_1 & R_2 = Resistor Set



YSI 44020 Thermistor Network
R_1, R_2 & R_3 = Resistor Set

Since each network has a unique resistance versus temperature relationship, it follows that each will have a different sensitivity in the voltage mode. This relationship may be defined as

$$E_{out} = (mE_{in})\,X + (bE_{in})$$

Where: E_{out} = voltage output
m = voltage change per degree (slope)
E_{in} = input voltage
X = temperature in degrees
b = voltage at 0° and 1 volt E_{in} (0° offset or intercept)

The values for these slope and intercept values are on the same pages as the resistance mode values. How to use these equations in circuit development is in the Technical Information Section.

YSI Thermilinear Component Specifications

Component	Maximum Operating Temperature	Accuracy & Interchangeability
YSI 44018	105°C (220°F)	±0.15°C

YSI Thermilinear Network Specifications

YSI Networks Using 44018

44201

Linear Range
0 to +100°C

Linearity Deviation
±0.216°C

44018
T_1 = 6,000 Ω @ 25°C
T_2 = 30,000 Ω @ 25°C

Resistance Mode
$R_t = (-17.115)\,T + 2768.23$

E_o Positive Mode
$E_{out} = (+0.0053483\,E_{in})\,T + 0.13493\,E_{in}$

E_o Negative Mode
$E_{out} = (-0.0053483\,E_{in})\,T + 0.86507\,E_{in}$

44301
R_1 = 3200 Ω
R_2 = 6250 Ω

E_{in} Max	I_t Max	Min RL
2.0 V	625 µA	10 MΩ

Resistor Error
±0.14°C @ 0°C, ±0.03°C @ +100°C

44202

Linear Range
-5 to +45°C

Linearity Deviation
±0.065°C

44018
T_1 = 6,000 Ω @ 25°C
T_2 = 30,000 Ω @ 25°C

Resistance Mode
$R_t = (-32.402)\,T + 4593.39$

E_o Positive Mode
$E_{out} = (+0.0056846\,E_{in})\,T + 0.194142\,E_{in}$

E_o Negative Mode
$E_{out} = (-0.0056846\,E_{in})\,T + 0.805858\,E_{in}$

44302
R_1 = 5700 Ω
R_2 = 12,000 Ω

E_{in} Max	I_t Max	Min RL
3.5 V	615 µA	10 MΩ

Resistor Error
±0.12°C @ -5°C, ±0.07°C @ +45°C

44203

Linear Range
-30 to +50°C

Linearity Deviation
±0.16°C

44018
T_1 = 6,000 Ω @ 25°C
T_2 = 30,000 Ω @ 25°C

Resistance Mode
$R_t = (-127.096)\,T + 12175$

E_o Positive Mode
$E_{out} = (+0.0067966\,E_{in})\,T + 0.34893\,E_{in}$

E_o Negative Mode
$E_{out} = (-0.0067966\,E_{in})\,T + 0.65107\,E_{in}$

44303
R_1 = 18,700 Ω
R_2 = 35,250 Ω

E_{in} Max	I_t Max	Min RL
3.0 V	475 µA	10 MΩ

Resistor Error
±0.12°C @ -30°C, ±0.02°C @ +50°C

44204

Linear Range
-2 to +38°C

Linearity Deviation
±0.03°C

44018
T_1 = 6,000 Ω @ 25°C
T_2 = 30,000 Ω @ 25°C

Resistance Mode
$R_t = (-32.1012)\,T + 4603.11$

E_o Positive Mode
$E_{out} = (+0.00563179\,E_{in})\,T + 0.192437\,E_{in}$

E_o Negative Mode
$E_{out} = (-0.00563179\,E_{in})\,T + 0.807563\,E_{in}$

44301
R_1 = 3200 Ω
R_2 = 6250 Ω

E_{in} Max	I_t Max	Min RL
4.0 V	685 µA	10 MΩ

Resistor Error
±0.13°C @ -2°C, ±0.08°C @ +38°C

YSI Thermilinear Component Specifications

Component	Maximum Operating Temperature	Accuracy & Interchangeability
YSI 44019A	85°C (185°F)	±0.4°C (0 to 85°C), ±0.8°C (0 to -55°C)
YSI 44020	55°C (131°F)	±0.1°C

YSI Thermilinear Network Specifications

YSI Network Using 44019A

44211A	**Linear Range**		**Linearity Deviation**
	-55 to +85°C		±1.1°C
44019A	**Resistance Mode**		
T_1 = 1,000 Ω @ 25°C	$R_t = (-17.99)\,T + 2339$		
T_2 = 10,000 Ω @ 25°C	**E_o Positive Mode**		**E_o Negative Mode**
	$E_{out} = (+0.005068\,E_{in})\,T + 0.3411\,E_{in}$		$E_{out} = (-0.005068\,E_{in})\,T + 0.6589\,E_{in}$
44311A	**E_{in} Max**	**I_t Max**	**Min RL**
R_1 = 3550 Ω	2.0 V	833 µA	10 MΩ
R_2 = 6025 Ω	**Resistor Error**		
	±0.18°C @ -55°C, ±0.02°C @ +85°C		

YSI Network Using 44020

44212	**Linear Range**		**Linearity Deviation**
	-50 to +50°C		±0.09°C
44020	**Resistance Mode**		
T_1 = 2,000 Ω @ 25°C	$R_t = (-129.163)\,T + 13698.23$		
T_2 = 15,000 Ω @ 25°C	**E_o Positive Mode**		**E_o Negative Mode**
T_3 = 45,000 Ω @ 25°C	$E_{out} = (+0.00559149\,E_{in})\,T + 0.40700\,E_{in}$		$E_{out} = (-0.00559149\,E_{in})\,T + 0.59300\,E_{in}$
44312	**E_{in} Max**	**I_t Max**	**Min RL**
R_1 = 23,100 Ω	3.5 V	700 µA	10 MΩ
R_2 = 88,200 Ω	**Resistor Error**		
R_3 = 38,000 Ω	±0.15°C @ -50°C, ±0.03°C @ +50°C		

Thermilinear Definitions

Thermilinear Component YSI 44018, 44019A or 44020 thermistor.

Resistor Set YSI 44301, 44302, 44303, 44304, 44311A or 44312 resistor sets consist of 2 resistors (3 for 44312) used with a Thermilinear component to create a Thermilinear network.

Thermilinear Network A Thermilinear component and corresponding resistor set.

Linear Range Temperature range over which linearity deviation applies.

Linearity Deviation Deviation, in degrees, between actual network values and calculated straight line. This is stated as worst case; actual deviation is roughly sinosoidal about the calculated nominal.

Resistance Mode Formula for calculating R vs T.

E_o Negative Mode Formula for calculating the voltage across thermistor/resistor parallel network (bottom of bridge).

E_o Positive Mode Formula for calculating the voltage across R_1 (top of bridge).

E_{in} Max & I_t Max Values below which thermistors exhibit minimal self heating; determined using 8mW/°C dissipation. E_{in} max and I_t max values may be exceeded 5 times without damaging probe.

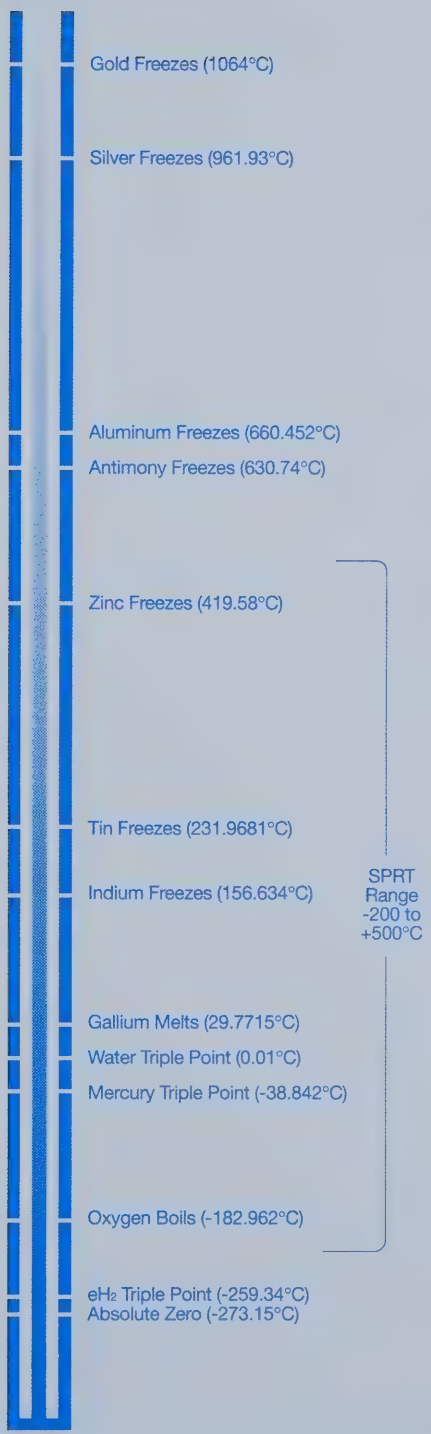
Load Resistance Minimum, RL The minimum recommended resistive impedance. Lower values may adversely affect linearity and other performance characteristics of the network.

Resistor Error Possible circuit error in degrees, induced by ±1% fixed resistors.

SECTION 2

Special Test Services

- **YSI Facilities**
- **Custom Specifications**
- **Thermistor Calibration**
- **Platinum RTD Calibration**
- **Standard Platinum Resistance Thermometers**



Special Test Services

Our Facilities

We have the facilities to qualify our thermistors to meet NASA specification GSFC S-311-P-18. We can also perform tests referenced in MIL T-23648.

YSI has resistance temperature measurement capabilities to determine the resistance of thermistors from -80 to +125°C. Resolution is normally at least 1 part per 10,000 for the zero power resistance measurement. All temperature measurements are traceable to the National Institute of Standards and Technology (NIST).

Custom Specifications

Many leading aerospace companies have developed their own specifications for qualifying, screening and using thermistors in high-reliability applications. We welcome your inquiry on special measurement points or screening tests that use our capabilities, whether listed in MIL T-23648, GSFC-311-P-18 or your own requirements.

Thermistor Calibration

YSI will calibrate thermistors and thermistor probes based on ITS-90. All calibrations are traceable to NIST or derived from accepted values of physical constants. We furnish a certificate of calibration and a certificate of traceability with every thermistor we calibrate. We calibrate thermistor reference probes in a stirred oil bath in comparison with an NIST-calibrated SPRT. Standard calibration temperatures are -40, 0, +25, +40, +70, +100 and +125°C.

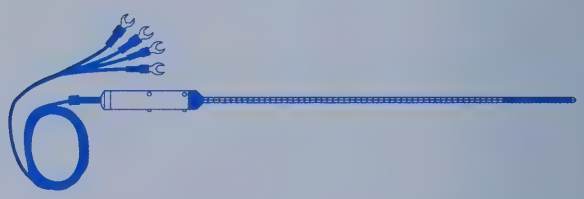
Platinum RTD Calibration

YSI will calibrate platinum RTDs based on ITS-90. All calibrations are traceable to NIST or derived from accepted values of physical constants. We furnish a certificate of calibration and a certificate of traceability with every RTD we calibrate. Standard calibration temperatures are -40, 0, +25, +40, +70, +100 and +125°C.

We can also calibrate your RTD at any reference point of ITS-90 between -189 and +420°C.

Standard Platinum Resistance Thermometers

These traditional Standard Platinum Resistance Thermometers (SPRTs) are the world's working standard of temperature. We have been building them since 1981 from a Leeds and Northrup design.



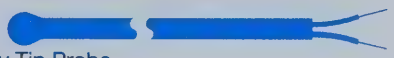
Made from carefully wound helixes of reference-grade platinum, these thermometers are highly stable over long periods and measure from -200 to +500°C. Resistance is about 25.5 ohms at 0°C.

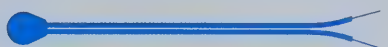
We will calibrate any SPRT in good condition manufactured by L & N or YSI. We can often repair broken thermometers as well.

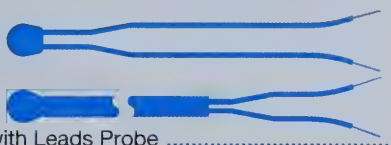
Call us to discuss your application at 800 765-4974. Fax 513 767-9353

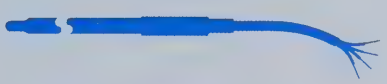
SECTION 3

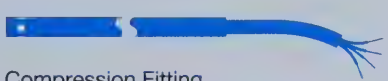
Configure-to-Order Thermistor Probes

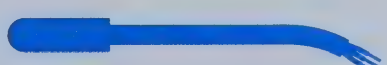


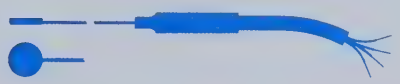


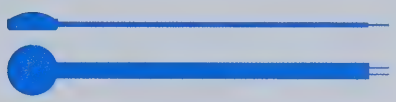


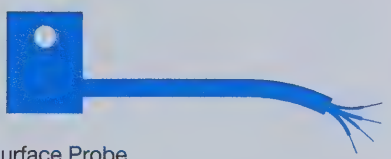


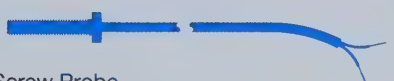


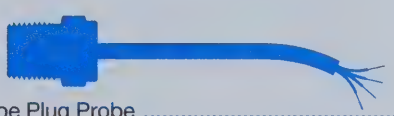


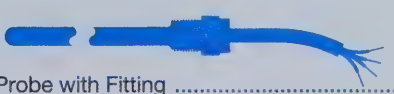


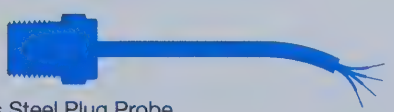












About Configure-to-Order Probes

YSI configure-to-order probes offer the flexibility of custom design at the price of standard parts. Match any YSI Precision Interchangeable Thermistor with cable and sheath options to create a custom probe for your temperature measurement application.

The following pages detail the materials we use, time constants and explain how to construct a probe to meet your requirements.

Operating Temperatures

If you plan to use your probe above 100°C, you must select options that can withstand higher temperature. Probes with glass thermistors, stainless steel sheaths and Teflon cable are rated to 200°C.

Thermistor Components

Choose thermistors from any components shown in Section 1. You may design probes to use any YSI thermistor.

YSI 44000 Series Thermistors
- Cost-effective
- ±0.2°C or ±0.1°C interchangeability

YSI 44000 Series Thermilinear Components
- Linear outputs

YSI 45000 Series Thermistors
- Stable
- High operating temperature

YSI 46000 Series Thermistors
- Unsurpassed long-term stability
- ±0.2°C to ±0.05°C interchangeability

Probe Materials

Epoxy–We match epoxies to design requirements.

Stainless Steel–316SS. Tubular probes have rolled ends and uniform wall thickness throughout, hermetic tips and a medical grade polished finish.

Glass–The YSI 036 glass probe is Pyrex. The tip is melted to form a hermetic seal.

Teflon–We use TFE Teflon for the YSI 037 Probe, FEP for the YSI 015.

Aluminum–We use 2024 T4 in the YSI 083 probe.

Brass–Screws and fittings per ASTM B16 and ASTM B453.

Typical Time Constants

Time constants below are a result of testing performed in a water bath with a flow rate of 3 feet per second. Time constants in still air are typically 10 times greater. Use this data for comparison only. Your results may differ depending on application.

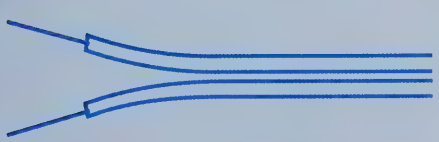
Probe Style	Time Constant	Probe Style	Time Constant
010	5.0 sec	082	0.3 sec
011	2.0	083	8.0
012	3.0	090	2.0
014	1.0-3.0	091	3.5
015	2.5	092	5.0
030	3.0	093	2.5
031	3.8	094	4.0
032	4.5	095	5.5
033	3.0	096	10.0
034	3.8	097	15.0
035	4.5	098	20.0
036	4.2	099	25.0
037	6.0	100	3.0
050	1.0	101	3.4
051	2.0	102	4.5
052	3.0	190	15.0
070	15.0	191	20.0
071	5.0	192	25.0
080	0.6	193	30.0
081	1.1		

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

Cable & Lead Styles

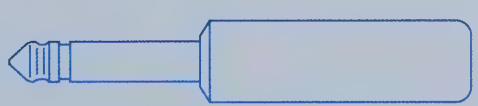
Type	Description	Temperature Range	Color Available	Gauge	Conductor/Shield	Typical Outer Diameter 1-wire	2-wire	3-wire	4-wire
RP	Round PVC	-40 to +105°C		24 AWG	stranded/-	-	0.147"	0.147"	0.170"
RPS	Round PVC	-55 to +105°C		24 AWG	stranded/foil	-	0.150"	0.160"	0.180"
RPM	Round PVC	-55 to +105°C		28 AWG	stranded/-	-	0.100"	0.115"	0.135"
RT	Round TFE Teflon	-65 to +200°C		26 AWG	stranded/-	-	01.05"	0.125"	0.125"
RTS	Round TFE Teflon	-65 to +200°C		26 AWG	stranded/braid	-	0.120"	0.126"	0.136"
RN	Round SJO Neoprene	+60°C max		18 AWG	stranded/-	-	0.300"	0.330"	0.355"
RNS	Round SJO Neoprene	+60°C max		18 AWG	stranded/braid	-	0.295"	0.340"	0.340"
FP	Flat PVC	-40 to +105°C		24 AWG	stranded/-	-	.058" x .115"	.044" x .150"	
FT	Flat TFE Teflon	-65 to +200°C		30 AWG	stranded/-	-	.032" x .80"	.032" x .125"	
IP	Individual PVC	-55 to +105°C	C	28 AWG	stranded/-	0.034"	-	-	-
IPL	Individual PVC	-40 to +80°C	C	22 AWG	stranded/-	0.057"	-	-	-
IPM	Individual PVC	-55 to +105°C		32 AWG	stranded/-	0.028"	-	-	-
IT	Individual TFE Teflon	-60 to +200°C	C	28 AWG	stranded/-	0.027"	-	-	-
ITL	Individual TFE Teflon	-60 to +200°C	C	24 AWG	stranded/-	0.036"	-	-	-
ITM	Individual TFE Teflon	-60 to +200°C		32 AWG	stranded/-	0.021"	-	-	-
IV	Individual varnish-insulated	-40 to +180°C		32 AWG	solid/-	0.008"	-	-	-
IC	Individual tinned copper	NA		32 AWG	solid/-	0.008"	-	-	-
ID	Individual Dumet	NA		32 AWG	solid/-	0.008"	-	-	-

Terminations



Stripped and Tinned Leads (ST)

#6 Spade Lugs (SP)



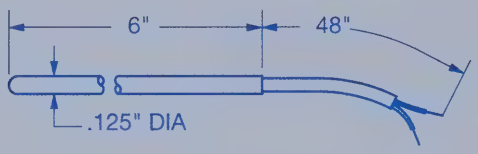
¼" Phone Plug (PH)

Off-the-Shelf Probes

We offer off-the-shelf probes in our most popular styles with minimal lead times and discount pricing. Contact YSI Customer Service for information on delivery and prices for the probes below.

Tubular Probes

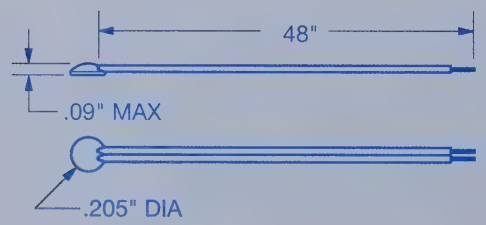
- ±0.1°C interchangeability
- 2252 Ω or 10K Ω at 25°C
- Maximum temperature: 75°C
- Time constant: 3.0 seconds typical
- 6" length, 1/8" OD, 316SS, rolled-end sheath
- 48" of 28 AWG stranded PVC cable
- Stripped and tinned termination



Order SP030-68 for the 2252 Ω probe.
Order SP030-69 for the 10K Ω probe.

Surface-Temperature Probes

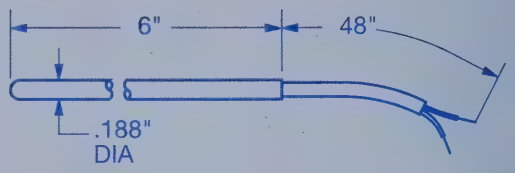
- Time constant: 0.3 seconds typical
- ±0.1°C interchangeability
- 2252 Ω or 10K Ω at 25°C
- Maximum temperature: 75°C
- 0.205" OD stainless-steel-faced sensor
- 48" of 30 AWG flat Teflon lead
- Stripped and tinned termination



Order SP082-39 for the 2252 Ω probe.
Order SP082-40 for the 10K Ω probe.

High-Temperature (200°C) Tubular Probes

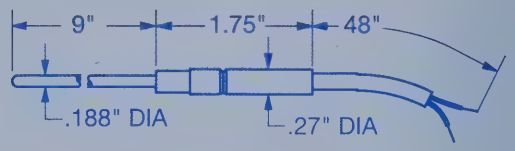
- Maximum temperature: 200°C
- 2252 Ω or 10K Ω at 25°C
- ±0.1°C interchangeability
- 6" length, 3/16" OD, 316SS, rolled-end sheath
- 48" of 26 AWG round shielded TFE Teflon cable
- Stripped and tinned termination
- Time constant: 3.8 seconds typical



Order SP031-70 for the 2252 Ω probe.
Order SP031-71 for the 10K Ω probe.

Super-Stable Hermetic Tubular Probes

- ±0.05°C interchangeability
- Hermetically sealed
- 2252 Ω at 25°C
- Maximum temperature: 200°C
- 9" length, 3/16" OD, 316SS, rolled-end sheath
- 48" of 26 AWG round shielded TFE Teflon cable
- Stripped and tinned termination
- Time constant: 3.8 seconds typical



Order SP034-39.

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

How to Order Configure-to-Order Probes

If the off-the-shelf probes on the previous page don't meet your needs, you can easily configure your own probe from our many thermistor, sheath and cable options. We've created an example below of how to do it yourself.

1. Choose the probe style that matches your application. Turn to the page in this section that lists the options for that style. For our example, we've chosen the YSI 030.

2. Select the thermistor that best suits your need from the choices on the probe page.

3. Select the sheath length in inches.

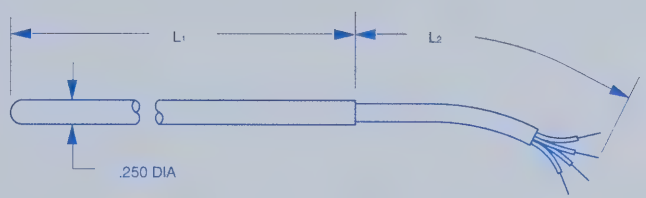
4. Select a cable or lead type to match your requirements.

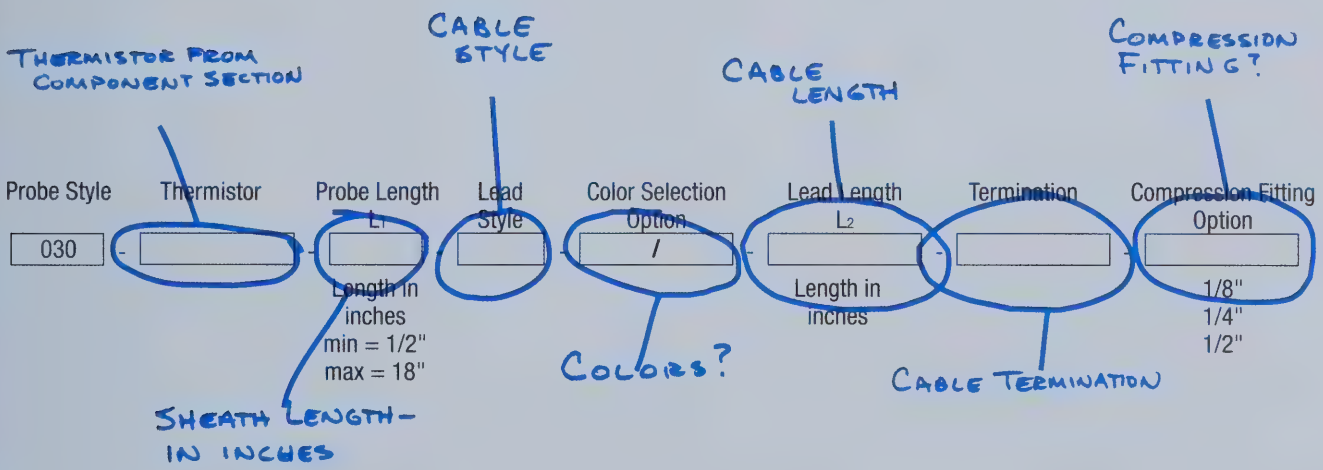
5. If you're using individual leads, and color coding is important, enter those colors here. Non-Thermilinear parts are supplied with black individual leads.

6. Select the length of cable in inches.

7. Indicate cable termination: ST, PH, SL.

8. Choose a compression fitting if required; designate thread size.

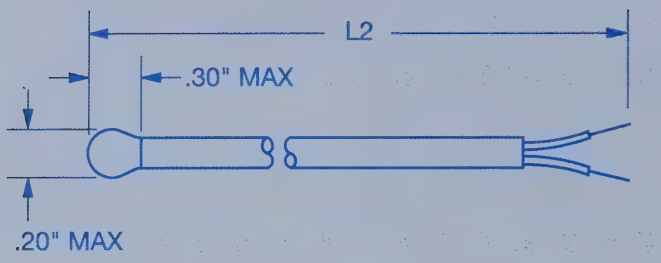




We Build OEM Probes

If you don't find a configure-to-order probe that suits your application, we can design probes specifically for your application.

YSI 010 Round Epoxy Tip Probe



The **YSI 010** probe provides a good mix of ruggedness, flexibility and response time. Epoxy encapsulation provides high compression strength and the PVC cable provides abrasion protection.

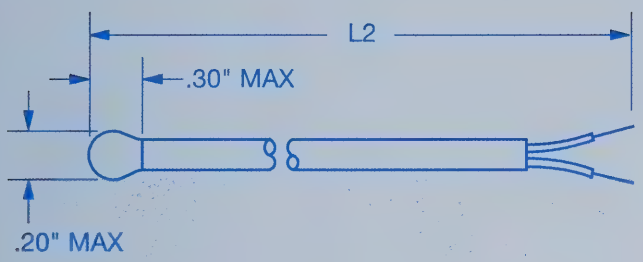
This design is excellent for pot-in-place applications such as equipment environmental temperatures, instrument internals, and supplying temperature data of test subjects for compensation. This probe is not designed for long wet immersion. Use the YSI 070 and 071 instead.

Typical Time Constant: 5.0 seconds

Probe Style		Thermistor		Probe Length L_1		Lead Style		Lead Length L_2		Termination
010	-		-	NA	-		-		-	
				Length in inches				Length in inches		

Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP	•	•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS	•	•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM	•	•	•	•	•	•	3"	1200"	•	•	•

YSI 011 Round PVC Tip Probe



The **YSI 011** probe combines ruggedness, flexibility and short response time. The vinyl plastisol encapsulation protects against mechanical shock. The PVC cable construction provides abrasion protection.

Since the thermistor and cable are constructed from same material, the seal is as good as the cable. This design is excellent for pot-in-place applications such as natural environmental temperatures and supplying temperature data of test subjects for compensation. This design will tolerate many, many days of immersion without internal water shunts.

Typical Time Constant: 2.0 seconds

Probe Style		Thermistor		Probe Length L_1		Lead Style		Lead Length L_2		Termination
011	-		-	NA	-		-		-	
				Length in inches				Length in inches		

3

Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP	•	•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS	•	•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM	•	•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP	•	•	•	•	•	•	1"	120"	•	•	•

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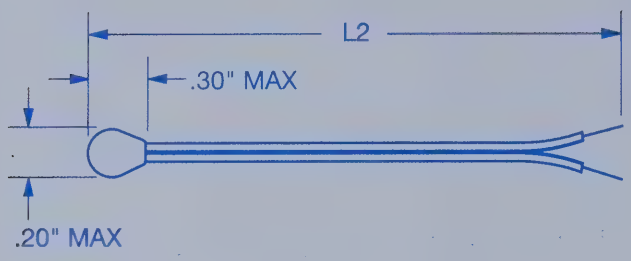
YSI 012 Flat Epoxy Tip Probe



The **YSI 012** probe is designed for the similar purposes as the YSI 010 probe. The YSI 012 offers parallel leads and a faster response time. Its shape allows the insertion into areas which are an integral part of the sample environment.

This style permits more accurate measurements of surfaces than the 010 style because the lead may be placed in contact with the surface more effectively.

Since the primary thermal transfer path is through the conductor (lead), it is important to have as much of the lead at the sample temperature as practical. This is especially critical with gas samples.

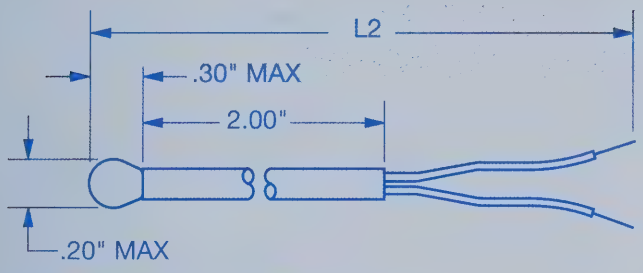
Typical Time Constant: 3.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Lead Length L_2	Termination
012		NA			
		Length in inches		Length in inches	

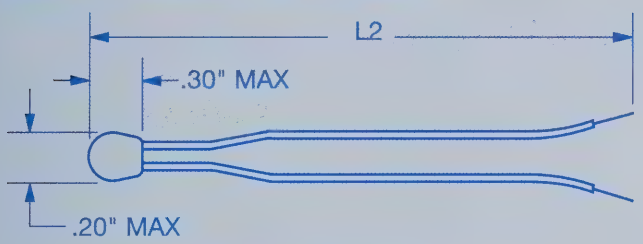
Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Thermistor: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Flat PVC	FP	•	•	•	•	•		1"	120"	•	•	•
Flat TFE Teflon	FT	•	•	•	•	•		1"	120"	•	•	•

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 014 Thermistor with Leads Probe



Glass-Encapsulated Thermistor



Epoxy-Encapsulated Thermistor

The **YSI 014** probe is constructed with individual leads. This allows for great flexibility in application. As with any sensor with leads, the stem artifact must be recognized. The advantage of the YSI 014 probe is the ability to control placement and insulation of the leads to maximize response time and reduce stem effect. This design lets you create a low stem effect, fast time constant and small volume sensor. YSI 014 probes are generally the lowest cost and are used frequently in instrumentation.

Typical Time Constant: 1.0 to 3.0 seconds

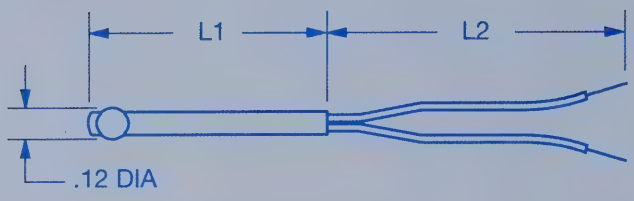
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
014		NA		/		
		Length in inches			Length in inches	

	Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
		Lead Style		Thermistor					Lead Length L2		Termination		
Individual PVC	IP	•	•		•	•	•		1"	48"	•	•	•
Individual Miniature PVC	IPM		•		•	•	•		1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•		1"	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•		1"	48"	•	•	•
Individual Varnish-Insulated	IV		•		•	•	•		0.5"	12"	•	•	•
Individual Tinned Copper	IC		•						0.5"	12"	•	•	•
Individual Dumet	ID		•	•					0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 015 Thermistor in Teflon Probe



The **YSI 015** probe's design allows it to resist attack from almost all chemicals in the industrial environment. The exceptions are hydrofluoric acid, alkaline metals, and a few other compounds. While Teflon is highly water-vapor-permeable, it's extremely resistant to attack by ionized compounds. The specific heat of Teflon is quite high, making the 015 a poor choice for gas temperature measurement.

A frequent application of the YSI 015 probe is temperature measurement and control of plating baths. When mounting the 015 probe in a chemically active environment, prevent splashing into the back of the tube.

Typical Time Constant: 2.5 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
015				/		
		Length in inches min = 1" max = 24"			Length in inches	

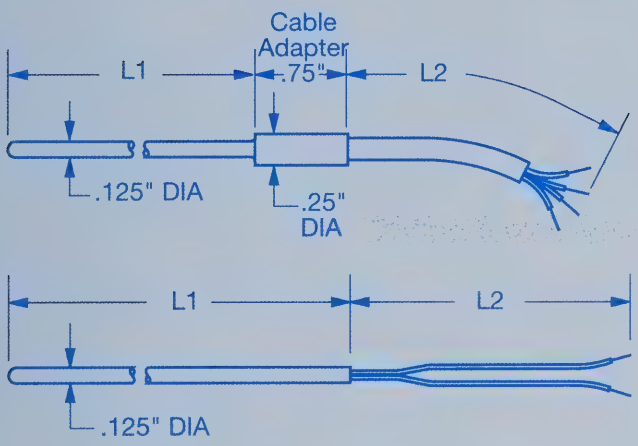
Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Thermistor: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Individual PVC	IP	•		•	•	•	1"	48"	•	•	•	
Individual Miniature PVC	IPM	•		•	•	•	1"	48"	•	•	•	
Individual TFE Teflon	IT	•	•	•	•	•	1"	48"	•	•	•	
Individual Miniature TFE Teflon	ITM	•	•	•	•	•	1"	48"	•	•	•	
Individual Varnish-Insulated	IV	•		•	•	•	0.5"	12"	•	•	•	
Individual Tinned Copper	IC	•					0.5"	12"	•	•	•	

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 030
1/8" OD
Tubular Probe



The **YSI 030** tubular probe is a 1/8" diameter 316 stainless steel assembly. Its primary application is measurement and control sensing in wet environments. Internal construction reduces stem effect errors by increasing the thermal path at the thermistor. Immersion depths will significantly affect measurement accuracy. To establish the appropriate immersion depth, follow the instructions in the Technical Information Section. The optional compression fitting simplifies insertion into a process flow.

Typical Time Constant: 3.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
030				/			
		Length in inches min = 1/2" max = 18"			Length in inches		1/8" 1/4" 1/2"

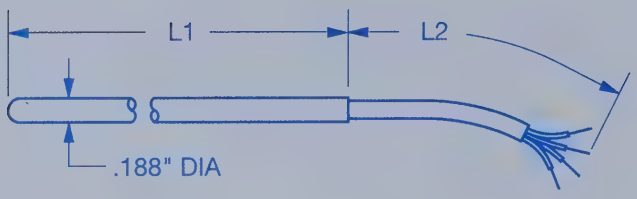
3

Cable	Code	Lead Style: .75" Long Adapter	Lead Style: Color Available	Thermistor: 44000 except Thermilinear	Thermistor: 44018	Thermistor: 44019A	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP	•		•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS	•		•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM	•		•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT	•		•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS	•		•	•	•	3"	1200"	•	•	•
Flat PVC	FP	•		•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT	•		•	•	•	1"	120"	•	•	•
Individual PVC	IP		•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM			•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT		•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL		•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM			•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV			•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 031
3/16" OD Tubular Probe



The **YSI 031** tubular probe is a 3/16" diameter 316 stainless steel assembly. Its primary application is measurement and control sensing in wet environments. Internal construction reduces stem effect errors by increasing the thermal path at the thermistor. Immersion depths will significantly affect measurement accuracy. To establish the appropriate immersion depth, follow the instructions in the Technical Information Section. The optional compression fitting simplifies insertion into a process flow.

Typical Time Constant: 3.8 seconds

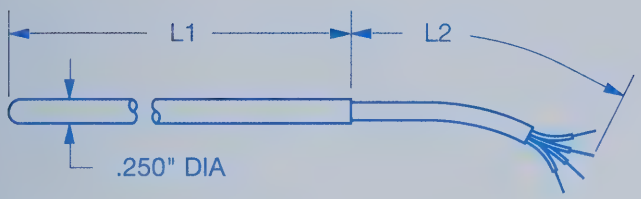
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
031 -		-	-	- / -		-	-
		Length in inches min = 1/2" max = 24"			Length in inches		1/8" 1/4" 1/2"

Cable	Code	Lead Style: Color Available	Thermistor: 44000 except Thermilinear	Thermistor: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L_2: Minimum Length	Lead Length L_2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•				1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 032
1/4" OD Tubular Probe



The **YSI 032** is a ¼" diameter 316 stainless steel assembly. Its primary application is measurement and control sensing in wet environments. Internal construction reduces stem effect errors by increasing the thermal path at the thermistor. Immersion depths will significantly affect measurement accuracy. To establish the appropriate immersion depth, follow the instructions in the Technical Information Section. The optional compression fitting simplifies insertion into a process flow.

Typical Time Constant: 4.5 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
032 -		-	-	- / -		-	-
		Length in inches min = 1/2" max = 36"			Length in inches		1/8" 1/4" 1/2"

3

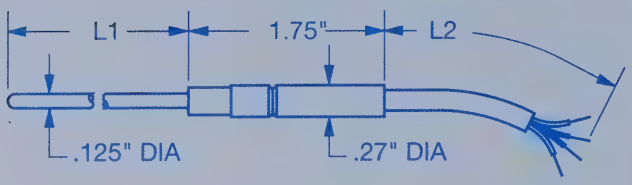
Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Lead Style: 44018	Lead Style: 44019A	Lead Style: 44020	Thermistor: Minimum Length	Thermistor: Maximum Length	Lead Length L2: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 033
1/8" OD Hermetic Tubular Probe



The **YSI 033** probe has the same properties as the YSI 030 with the notable exception of being hermetically sealed. The hermetic seal prevents condensation of water at the sensor or leads and eliminates electrical shunt error.

The transfer rate of water vapor is a function of the differential vapor pressure. At 0°C and 100% RH the condensing vapor pressure is 4.58 mm Hg and at 20°C and 50% RH the vapor pressure is 8.77 mm Hg. The differential pressure is 4.19 mm Hg. This is approximately 0.8 PSIG, which is significant over time. Multiple cycle and life studies (ask for document IB.12) demonstrate the value of this probe style for stability in long-term cooling fluid system applications. Compression fitting adaptability enhances the 033 probe's versatility.

Typical Time Constant: 3.0 seconds

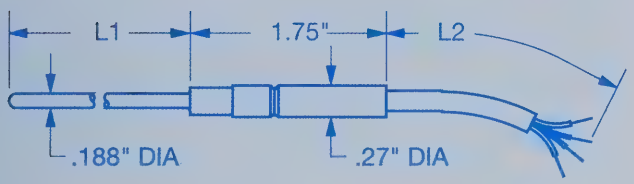
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
033 -		-	-	- / -		-	-
		Length in inches min = 1" max = 18"			Length in inches		1/8" 1/4" 1/2"

Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
		Lead Style					Thermistor		Lead Length L2		Termination	
Round PVC	RP		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 034
3/16" OD Hermetic Tubular Probe



The **YSI 034** probe has the same properties as the YSI 031 probe plus it's hermetically sealed. The hermetic seal prevents condensation at the sensor or leads and eliminates electrical shunt error. The transfer rate of water vapor is a function of the differential vapor pressure. At 0°C and 100% RH the condensing vapor pressure is 4.58 mm Hg and at 20°C and 50% RH the pressure is 8.77 mm Hg. The differential pressure is 4.19 mm Hg. This is approximately 0.8 PSIG, which is significant over time. Multiple cycle and life studies (ask for document IB.12) demonstrate the value of this probe for stability in long-term cooling fluid applications. Compression fitting adaptability enhances the YSI 034 probe's versatility.

Typical Time Constant: 3.8 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
034 -		-	-	- / -		-	-
		Length in inches min = 1" max = 24"			Length in inches		1/8" 1/4" 1/2"

3

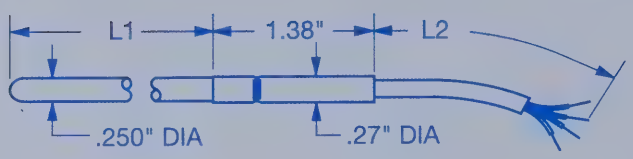
Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Lead Style: 44018	Lead Style: 44019A	Lead Style: 44020	Thermistor: Minimum Length	Thermistor: Maximum Length	Lead Length L2: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 035
1/4" OD Hermetic Tubular Probe



The **YSI 035** probe has the same properties as the YSI 032 probe plus it's hermetically sealed. The hermetic prevents condensation of water at the sensor or leads and eliminates electrical shunt error. The transfer rate of water vapor is a function of the differential vapor pressure. At 0°C and 100% RH the condensing vapor pressure is 4.58 mm Hg and at 20°C and 50% RH the pressure is 8.77 mm Hg. The differential pressure is 4.19 mm Hg. This is approximately 0.8 PSIG, which is significant over time. Multiple cycle and life studies (ask for document IB.12) demonstrate this probe's stability in long-term cooling fluid applications. Compression fitting adaptability enhances this probe's versatility.

Typical Time Constant: 4.5 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
035 -		-	-	- / -		-	-
		Length in inches min = 1" max = 36"			Length in inches		1/8" 1/4" 1/2"

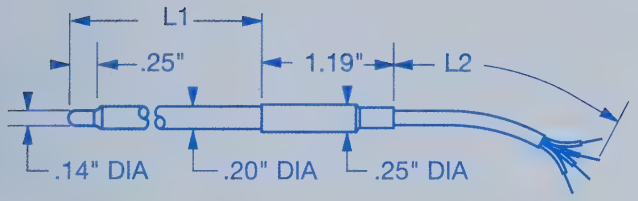
Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	45000/46000	44018	44019A	44020	Thermistor: Minimum Length	Maximum Length	Lead Length L2: Stripped & Tinned (ST)	Phone Plug (PH)	Termination: #5 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 036
Pyrex Probe



The **YSI 036** is a Pyrex-sheathed probe designed primarily for applications in wet chemistry. This glass probe is frequently used for measurement and control of temperatures in glass reactor systems. Pyrex is limited by its solubility and reaction in hydrofluoric acid and strong bases. In EPA-type applications, sample to sample carryover must be prevented.

The immersion depth of the tip may have a major effect on accuracy and repeatability. Refer to the Technical Information Section for guidelines to minimize stem effect error.

Pyrex is fragile. We recommend stainless steel tubular probes (YSI 030, 035) where practical. Use of compression fittings is feasible but they require Teflon ferrules.

Typical Time Constant: 4.2 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
036 -		-	-	- / -		-	-
		Length in inches min = 1" max = 18"			Length in inches		1/8" 1/4" 1/2"

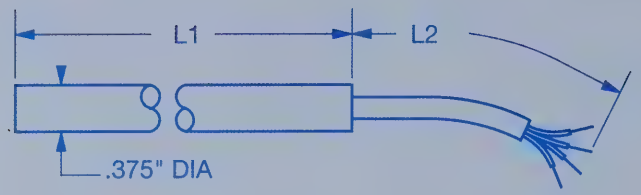
3

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	45000/46000	44018	44019A	44020	Thermistor: Minimum Length	Maximum Length	Lead Length L2: Stripped & Tinned (ST)	Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•		•		•	3"	1200"	•		•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•		•		•	1"	48"	•		•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•		•		•	1'	48"	•		•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 037
Teflon Probe



The **YSI 037** is a Teflon-sheathed probe designed primarily for use in wet chemistry. It's frequently used for measurement and control of temperatures in reactor systems. Use of Teflon is limited by its reaction in hydrofluoric acid and strong solutions of alkali metal compounds. There are several food products, such as fruit juices and edible oils, which either attack it or are absorbed. In EPA-type applications, sample to sample carryover must be prevented.

The immersion depth of the tip may have a major effect on accuracy and repeatability. Refer to the Technical Information Section for guidelines to minimize stem effect errors. Use of compression fittings is feasible but they require Teflon ferrules.

Typical Time Constant: 6.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
037				/		
		Length in inches min = 1" max = 10"			Length in inches	

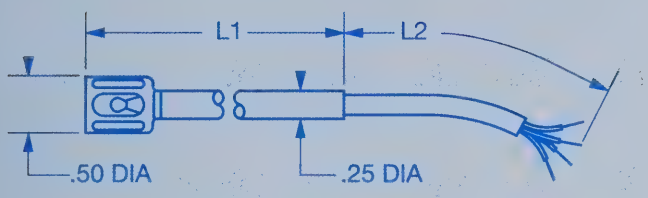
Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	45000/46000	44018	44019A	44020	Thermistor: Minimum Length	Maximum Length	Lead Length L2: Stripped & Tinned (ST)	Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 050 Bird Cage Air Probe



The **YSI 050** probe is designed for measurement of temperature in dry gas streams. The YSI 050 has the fastest response time of any standard protected probe. Typical applications include incubator and low-temperature drying systems.

While the thermistor is sealed with an insulating epoxy, the seal is not useful in aqueous solutions and should not be immersed. For exposure to wet or abrasive environments, use either the YSI 030 or the YSI 052.

While the sensor is shielded from radiant energy, if exposed to direct sunlight the cage may reradiate energy to the thermistor and bias the measurement.

Typical Time Constant: 1.0 seconds

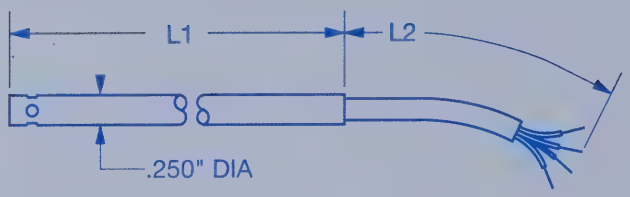
Probe Style		Thermistor		Probe Length L_1		Lead Style		Color Selection Option		Lead Length L_2		Termination
050	-		-		-		-	/	-		-	
				Length in inches min = 1 7/8" max = 12"						Length in inches		

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	45000/46000	44018	44019A	Thermistor: Minimum Length	Lead Length L_2: Maximum Length	Termination: Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 051 Air Probe for Compression Fitting



The **YSI 051** probe is designed for measurement of temperature in dry gas streams. The YSI 051 has the fastest response time of any standard probe that will pass through a compression fitting. Typical applications include dry gas measurements in pipes and lines.

While the thermistor is sealed with an insulating epoxy, the seal is not useful in aqueous solutions and should not be immersed. For exposure to wet or abrasive environments, use either the YSI 030 or the YSI 052.

While the sensor is shielded from radiant energy, if exposed to direct sunlight the cage may reradiate energy to the thermistor and bias the measurement.

Typical Time Constant: 2.0 seconds

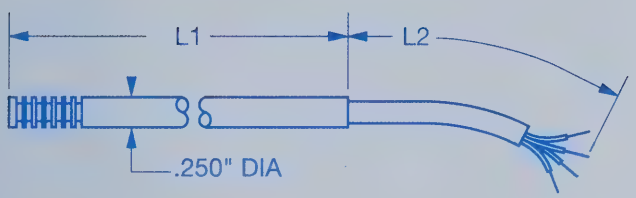
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
051 -		-	-	- / -		-	-
		Length in inches min = 1" max = 36"			Length in inches		1/8" 1/4" 1/2"

Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Lead Style: 44018	Thermistor: 44019A	Lead Length L_2: Minimum Length	Lead Length L_2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 052 Waterproof Airway Probe



The **YSI 052** probe is a completely enclosed gas temperature probe. Its primary benefit is pressure-resistant construction with fast response time. Applications include measurement in wet, abrasive or pressurized gas streams. The YSI 052 is also used to measure air temperature in fluidized baths. The 052 has been used to measure wet air float transport of powdered coal, plastic and freeze dried foods. The usual stem effect caveats apply to the 052; see the Technical Information Section for guidelines on minimizing stem effect error.

Typical Time Constant: 3.0 seconds

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Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination	Compression Fitting Option
052 -		-	-	- / -		-	-
		Length in inches min = 1 1/2" max = 36"			Length in inches		1/8" 1/4" 1/2"

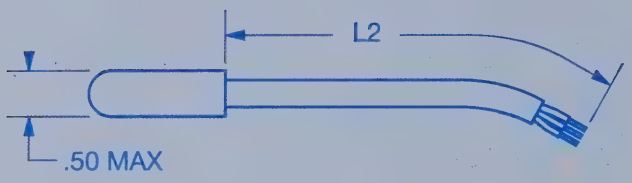
3

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Lead Style: 44018	Lead Style: 44019A	Thermistor: Minimum Length	Thermistor: Maximum Length	Lead Length L_2: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•		•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•		•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•		•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•		•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•		•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 070 Underwater Probe



The **YSI 070** probe is designed for very long-term burial in soil, concrete or other high-wetness environments. The 070 has inherent homogenous cable construction because the cable and the cap are both vulcanized neoprene. This assembly method provides a high-integrity seal as well as mechanical protection to the thermistor itself.

While not designed for deepwater immersion, the 070 is frequently used to measure the temperature of bogs, wetlands and wells. The 070 has demonstrated its ability to withstand the pounding punishment of burial in interstate roadways and airport runways.

Typical Time Constant: 15.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Lead Length L_2	Termination
070		NA			
		Length in inches		Length in inches	

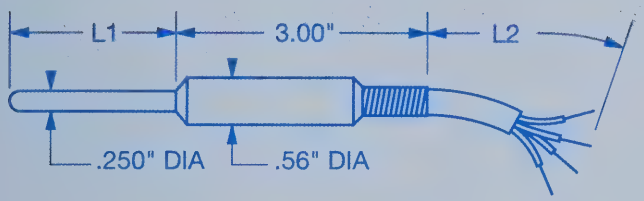
Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Lead Style: 44018	Lead Style: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round SJO Neoprene	RN	•	•	•	•	•	•	3"	2000"	•	•	•
Round Shielded SJO Neoprene	RNS	•	•	•	•	•	•	3"	2000"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 071 Deepwater Probe



The YSI 071 probe is designed for very long-term immersion at considerable depth. The 071 has a stainless/neoprene vulcanized seal with a molded external splice protector. This assembly method provides a high integrity seal as well as mechanical protection to the leads and the thermistor itself.

The 071 is specifically designed for deepwater immersion and is frequently used to measure the temperature of deepwater reservoirs, wetlands and wells. Multiple-year immersion at 2,000 feet is feasible. Several such installations are in place for thermal gradient power generation tests. The 071 has demonstrated its ability to withstand the forces of pier mounting in high-wave environments.

Typical Time Constant: 5.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Lead Length L_2	Termination	Compression Fitting Option
071 -		-	-	-	-	-
		Length in inches min = 2" max = 12"		Length in inches		1/8" 1/4" 1/2"

3

Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
		Lead Style					Thermistor		Lead Length L2		Termination	
Round SJO Neoprene	RN	•	•	•	•	•		3"	2000"	•	•	•
Round Shielded SJO Neoprene	RNS	•	•	•	•	•		3"	2000"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 080 Banjo Surface Probe

The **YSI 080** probe is designed for handheld surface temperature applications. The design provides fast response and minimal stem effect error, while providing an electrically isolated thermistor. Since the 080 has a large capture area and small mass, it's also useful for sampling measurement of gas and air streams.

All flat surface sensors require the best contact feasible while protecting the noncontacting surface from high levels of radiant energy. This can be accomplished by placing a reflective surface between the sensor and the source.

Typical Time Constant: 0.6 seconds

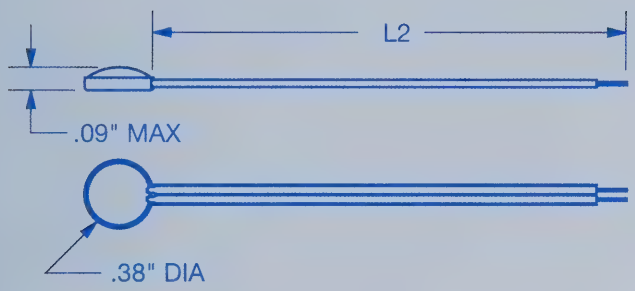
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
080				/		
		Length in inches min = 1" max = 12"			Length in inches	

Cable	Code	Color Available	44000 except Thermilinear	44018	44019A	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
		Lead Style			Thermistor		Lead Length L2		Termination	
Round PVC	RP		•	•	•	3"	1200"	•	•	•
Round Shielded PVC	RPS		•	•	•	3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	3"	1200"	•	•	•
Flat PVC	FP		•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 081 Surface Probe



The **YSI 081** probe is designed for permanent or temporary fixed-mount surface temperature applications. The construction of the probe provides very fast response and minimal stem effect error when used with relatively lightweight leads and mounting the leads. The thermistor is electrically isolated from the case.

One application of the 081 is the measurement of coil and radiator temperatures in heat exchangers.

All flat surface sensors require good surface contact while protecting the noncontact surface from high levels of radiant energy. This can be accomplished by placing a reflective surface between the sensor and the source. The 081 is not waterproof.

Typical Time Constant: 1.1 seconds

Probe Style		Thermistor		Probe Length L_1		Lead Style		Color Selection Option		Lead Length L_2		Termination
081	-		-	NA	-		-	/	-		-	
				Length in inches						Length in inches		

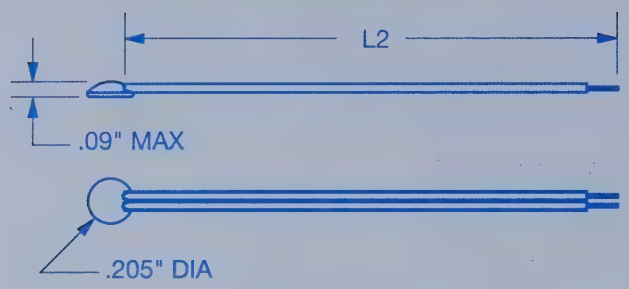
Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 44018	Lead Style: 44019A	Thermistor: Minimum Length	Thermistor: Maximum Length	Lead Length L_2: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Flat PVC	FP		•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	1"	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	1"	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 082 Small Surface Probe



The **YSI 082** probe, the smallest diameter and fastest responding of the surface styles, is designed for surface temperature applications. The 082 is electrically isolated and provides extremely fast response while minimizing stem effect errors.

One application of the 082 is the measurement of coil and radiator temperatures in heat exchangers.

All flat surface sensors require good surface contact while protecting the noncontact surface from high levels of radiant energy. This can be accomplished by placing a reflective surface between the sensor and the source. The 082 is not waterproof.

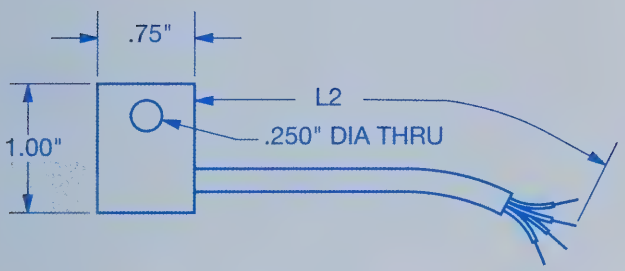
Typical Time Constant: 0.3 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Lead Length L_2	Termination
082		NA			
		Length in inches		Length in inches	

Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 44018	Thermistor: 44019A	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Flat PVC	FP	•	•	•	1"	None	•	•	•	
Flat TFE Teflon	FT	•	•	•	1"	None	•	•	•	
Individual Miniature PVC	IPM	•	•	•	1"	48"	•	•	•	
Individual Miniature TFE Teflon	ITM	•	•	•	1"	48"	•	•	•	
Individual Varnish-Insulated	IV	•	•	•	0.5"	12"	•	•	•	

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 083 Attachable Surface Probe



The **YSI 083** surface-temperature probe is designed for bolt-in-place applications. This is the most rugged of the surface temperature probe configurations. With the use of a thermal transfer compound, the 083 collects accurate temperature data because it's in intimate contact with the body to be measured.

The 083 is frequently used to measure, monitor and control temperatures of small motors, heat exchangers and fluid pumping systems.

All flat surface sensors require good surface contact while protecting the noncontact surface from high levels of radiant energy. This can be accomplished by placing a reflective surface between the sensor and the source.

Typical Time Constant: 8.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
083		NA		/		
		Length in inches			Length in inches	

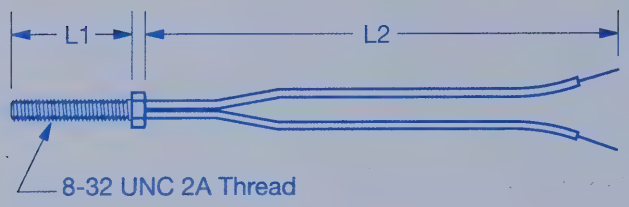
3

Cable	Code	Lead Style: Color Available	Thermistor: 44000 except Thermilinear	Thermistor: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•		3"	1200"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	1200"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	1200"	•	•	•
Round Shielded TFE Teflon	RTS		•	•				3"	1200"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•		1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 090
8-32 Brass
Screw Probe



The **YSI 090** probe is a thermistor mounted in a 8-32 brass hex head bolt. The design is especially useful for the measurement of relatively thick samples that are under vibration. The lead should not be excessively flexed in high vibration environments. Brass provides an excellent thermal pathway and is much less susceptible than stainless steel to spurious heat source errors.

Typical Time Constant: 2.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
090 -		-	-	/	-	-
		Length in inches min = 1/8" max = 1/2" Specify in 1/8" increments			Length in inches	

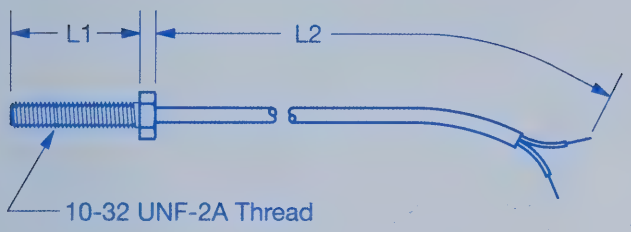
Cable	Code	Color Available	44000 except Thermilinear	44018	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
		Lead Style			**Thermistor**		**Lead Length L2**		**Termination**
Flat TFE Teflon	FT		•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 091
10-32 Brass Screw Probe



The **YSI 091** probe is a thermistor mounted in a 10-32 brass hex head bolt. The design is especially useful for the measurement of relatively thick samples which are under vibration. The lead should not be excessively flexed in high vibration environments. Brass provides an excellent thermal pathway and is much less susceptible than stainless steel to spurious heat source errors.

Typical Time Constant: 3.5 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
091				/		
		Length in inches min = 1/8" max = 1" Specify in 1/8" increments			Length in inches	

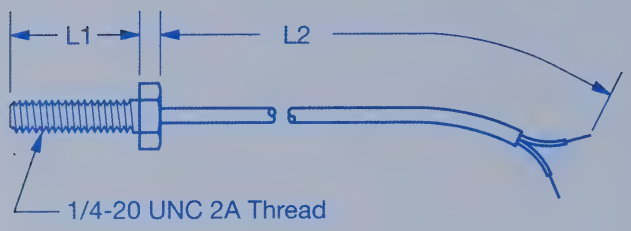
3

		Lead Style			Thermistor					Lead Length L2		Termination		
Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Round Miniature PVC	RPM		•	•	•	•		3"	120"	•	•	•
Flat PVC	FP		•	•				1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•		1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•				1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 092
1/4-20 Brass Screw Probe



The **YSI 092** probe is a thermistor mounted in a ¼-20 brass hex head bolt. The design is especially useful for measuring relatively thick samples which are under vibration. The lead should not be excessively flexed in high vibration environments. Brass provides an excellent thermal pathway and is much less susceptible than stainless steel to spurious heat source errors.

Typical Time Constant: 5.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
092 -		-	-	- / -		-
		Length in inches min = 1/8" max = 1" Specify in 1/8" increments			Length in inches	

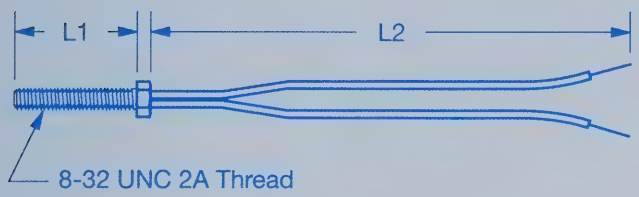
Cable	Code	Lead Style: Color Available	Thermistor: 44000 except Thermilinear	Thermistor: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round Miniature PVC	RPM		•	•	•	•		3"	120"	•	•	•
Flat PVC	FP		•	•				1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•		1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•				1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red:	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 093
8-32 Stainless Steel Probe



The **YSI 093** probe is a thermistor mounted in a 8-32 stainless steel hex head bolt. The design is especially useful for measuring relatively thick samples which are under vibration. The lead should not be excessively flexed in high vibration environments. Stainless steel provides a poorer thermal pathway than brass and may be susceptible to spurious heat source errors.

Typical Time Constant: 2.5 seconds

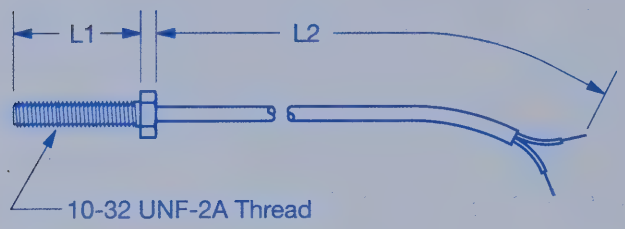
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
093				/		
		Length in inches min = 1/8" max = 1/2" Specify in 1/8" increments			Length in inches	

		Lead Style			Thermistor		Lead Length L2		Termination	
	Cable Code	Color Available	44000 except Thermilinear	44018	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Flat TFE Teflon	FT		•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red:Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 094
10-32 Stainless Steel Probe



The **YSI 094** probes a thermistor mounted in a 10-32 stainless steel hex head bolt. The design is especially useful for measuring relatively thick samples which are under vibration. The lead should not be excessively flexed in high vibration environments. Stainless steel provides a poorer thermal pathway than brass and may be susceptible to external heat source errors.

Typical Time Constant: 4.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
094 -		-	-	- / -		-
		Length in inches min = 1/8" max = 1" Specify in 1/8" increments			Length in inches	

Cable	Code	Lead Style: Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round Miniature PVC	RPM		•	•	•	•		3"	120"	•	•	•
Flat PVC	FP		•	•				1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•		1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•				1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

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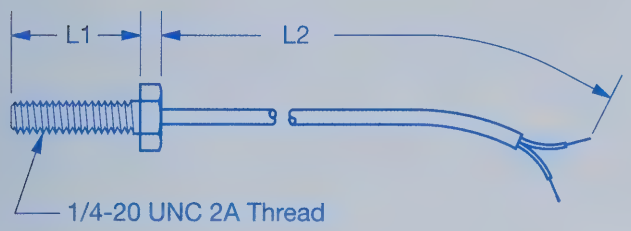
YSI 095
1/4-20 Stainless Steel Probe



The **YSI 095** probe is a thermistor mounted in a 1/4-20 stainless steel hex head bolt. The design is especially useful for measuring relatively thick samples which are under vibration. The lead should not be excessively flexed in high vibration environments. Stainless steel provides a poorer thermal pathway than brass and may be susceptible to external heat source errors.

Typical Time Constant: 5.5 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
095				/		
		Length in inches min = 1/4" max = 1" Specify in 1/8" increments			Length in inches	

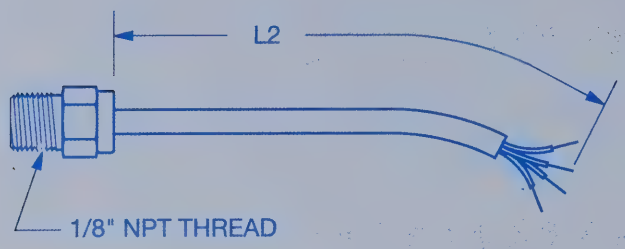
3

			Lead Style						Thermistor		Lead Length L2		Termination	
	Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Round Miniature PVC		RPM	•	•	•	•			3"	120"	•	•	•
Flat PVC		FP	•	•					1"	120"	•	•	•
Flat TFE Teflon		FT	•	•	•	•			1"	120"	•	•	•
Individual PVC	•	IP	•	•	•	•	•		1"	48"	•	•	•
Individual Large PVC	•	IPL	•	•					1"	48"	•	•	•
Individual Miniature PVC		IPM	•	•	•	•	•		1"	48"	•	•	•
Individual TFE Teflon	•	IT	•	•	•	•	•		1"	48"	•	•	•
Individual Large TFE Teflon	•	ITL	•	•	•	•	•		1'	48"	•	•	•
Individual Miniature TFE Teflon		ITM	•	•	•	•	•		1'	48"	•	•	•
Individual Varnish-Insulated		IV	•	•	•	•	•		0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 096
1/8" Brass
Pipe Plug Probe



The **YSI 096** probe is a thermistor mounted in a 1/8" NPT brass pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. While brass is an excellent conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 10.0 seconds

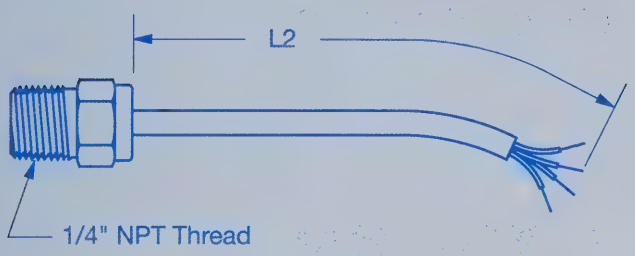
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
096		NA		/		
		Length in inches			Length in inches	

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 097
1/4" Brass
Pipe Plug Probe



The **YSI 097** probe is a thermistor mounted in a ¼" NPT brass pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. While brass is an excellent conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 15.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
097		NA		/		
		Length in inches			Length in inches	

3

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

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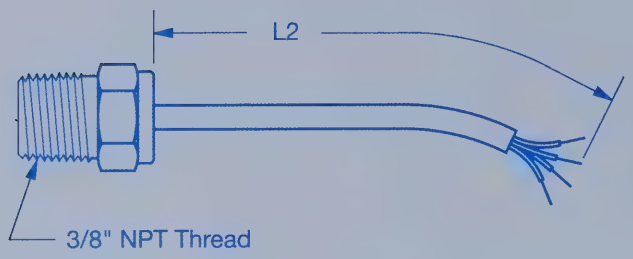
YSI 098
3/8" Brass
Pipe Plug Probe



The **YSI 098** probe is a thermistor mounted in a 3/8" NPT brass pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. While brass is an excellent conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 20.0 seconds

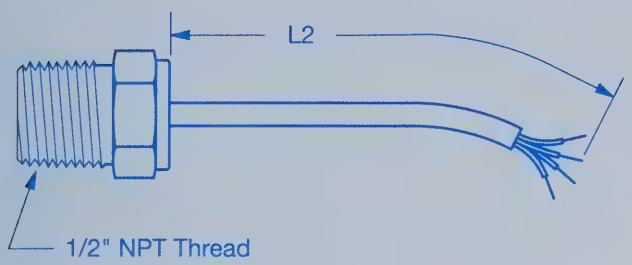
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
098		NA		/		
		Length in inches			Length in inches	

Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
		Lead Style					**Thermistor**		**Lead Length L2**		**Termination**	
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 099
1/2" Brass
Pipe Plug Probe



The **YSI 099** probe is a thermistor mounted in a 1/2" NPT brass pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. While brass is an excellent conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 25.0 seconds

Probe Style		Thermistor		Probe Length L_1		Lead Style		Color Selection Option		Lead Length L_2		Termination
099	-		-	NA	-		-	/	-		-	
				Length in inches						Length in inches		

3

Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
		Lead Style					Thermistor		Lead Length L2		Termination	
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•		•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•		•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

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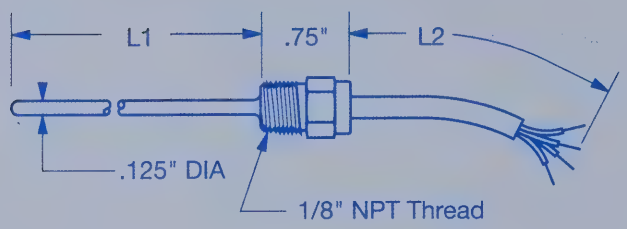
YSI 100
1/8" Tubular Probe with Fitting



The **YSI 100** probe is a 1/8" stainless steel tubular probe with a 1/8" NPT fitting. This design has a very high tolerance for pressure and in short lengths tolerates very high flow rates. The stainless steel construction provides protection from stress corrosion and cavitation etching.

Applications include accurate readings in pipelines. Exercise caution when using the probe in sea water.

Typical Time Constant: 3.0 seconds

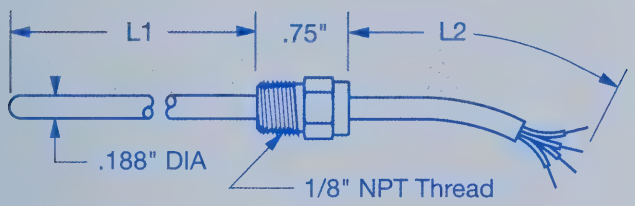
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
100				/		
		Length in inches min = 1/2" max = 18"			Length in inches	

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 44018	Lead Style: 44019A	Thermistor: Minimum Length	Thermistor: Maximum Length	Lead Length L2: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 101
3/16" Tubular Probe with Fitting



The **YSI 101** probe is a 3/16" OD stainless steel tubular probe with a 1/8" NPT fitting. This design has a very high tolerance for pressure and in short lengths tolerates very high flow rates. The stainless steel construction provides protection from stress corrosion and cavitation etching.

Applications include accurate readings in pipelines. Exercise caution when using the probe in sea water.

Typical Time Constant: 3.4 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
101		Length in inches min = 1/2" max = 24"		/	Length in inches	

3

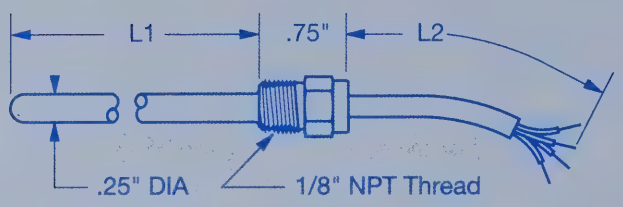
			Lead Style					Thermistor		Lead Length L2		Termination		
Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 102
1/4" Tubular Probe with Fitting



The **YSI 102** probe is a 1/4" OD stainless steel tubular probe with a 1/8" NPT fitting. This design has a very high tolerance for pressure and in short lengths tolerates very high flow rates. The stainless steel construction provides protection from stress corrosion and cavitation etching.

Applications include accurate readings in pipelines. Exercise caution when using the probe in sea water.

Typical Time Constant: 4.5 seconds

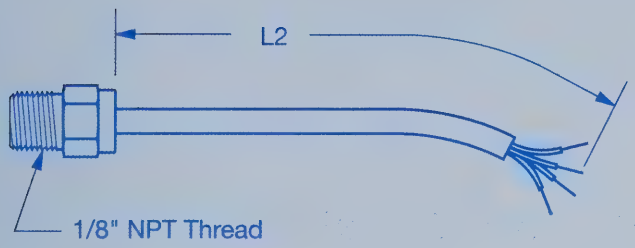
Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
102				/		
		Length in inches min = 1/2" max = 36"			Length in inches	

Lead Style			Thermistor		Lead Length L2		Termination		
Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 190
1/8" Stainless Steel Plug Probe



The **YSI 190** probe is a thermistor mounted in a 1/8" NPT stainless steel pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. Since stainless steel is not a good thermal conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 15.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
190	-	NA - Length in inches	-	- /	- Length in inches	-

3

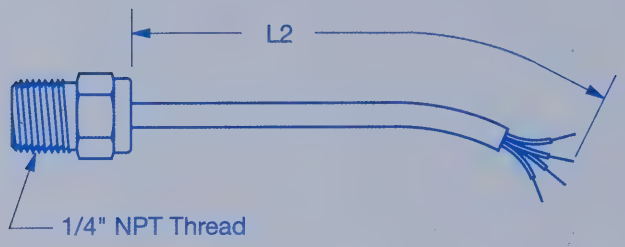
Cable	Code	Lead Style: Color Available	Thermistor: 44000 except Thermilinear	Thermistor: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L2: Minimum Length	Lead Length L2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

YSI 191
¼" Stainless Steel Plug Probe



The **YSI 191** probe is a thermistor mounted in a ¼" NPT stainless steel pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. Since stainless steel is not a good thermal conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 20.0 seconds

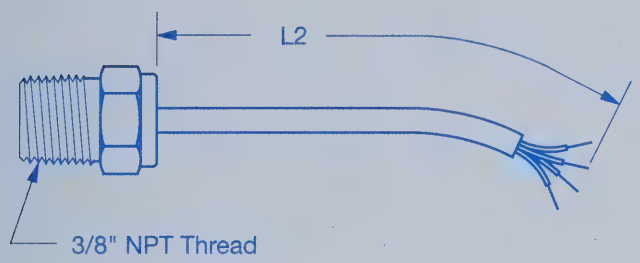
Probe Style		Thermistor		Probe Length L_1		Lead Style		Color Selection Option		Lead Length L_2		Termination
191	-		-	NA	-		-	/	-		-	
				Length in inches						Length in inches		

		Lead Style						Thermistor		Lead Length L2		Termination		
Cable	Code	Color Available	44000 except Thermilinear	45000/46000	44018	44019A	44020	Minimum Length	Maximum Length	Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

YSI 192
3/8" Stainless Steel Plug Probe



The **YSI 192** probe is a thermistor mounted in a 3/8" NPT stainless steel pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. Since stainless steel is not a good thermal conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 25.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
192		NA		/		
		Length in inches			Length in inches	

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	Lead Style: 45000/46000	Thermistor: 44018	Thermistor: 44019A	Thermistor: 44020	Lead Length L_2: Minimum Length	Lead Length L_2: Maximum Length	Termination: Stripped & Tinned (ST)	Termination: Phone Plug (PH)	Termination: #6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
Red: Red	Violet: Vio
Orange: Org	Gray: Gry
Yellow: Yel	White: Wht

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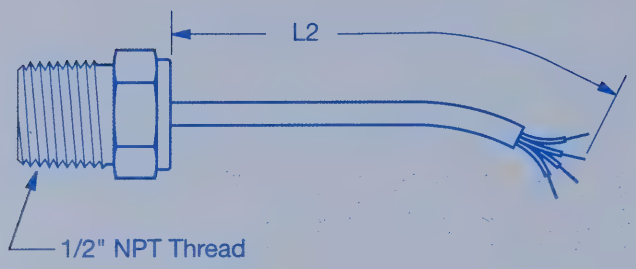
YSI 193 1/2" Stainless Steel Plug Probe



The **YSI 193** probe is a thermistor mounted in a 1/2" NPT stainless steel pipe plug. The pipe plug design allows for easy application to piping systems. The lead should not be excessively flexed in high vibration environments. Since stainless steel is not a good thermal conductor, unless care is taken, the wall temperature rather than the sample temperature will be measured.

Typical Time Constant: 30.0 seconds

Probe Style	Thermistor	Probe Length L_1	Lead Style	Color Selection Option	Lead Length L_2	Termination
193 -		NA -		/ -		-
		Length in inches			Length in inches	

Cable	Code	Color Available	Lead Style: 44000 except Thermilinear	45000/46000	Thermistor: 44018	44019A	44020	Lead Length L2: Minimum Length	Maximum Length	Termination: Stripped & Tinned (ST)	Phone Plug (PH)	#6 Spade Lugs (SP)
Round PVC	RP		•	•	•	•	•	3"	120"	•	•	•
Round Shielded PVC	RPS		•	•	•	•	•	3"	120"	•	•	•
Round Miniature PVC	RPM		•	•	•	•	•	3"	120"	•	•	•
Round TFE Teflon	RT		•	•	•	•	•	3"	120"	•	•	•
Round Shielded TFE Teflon	RTS		•	•	•	•	•	3"	120"	•	•	•
Flat PVC	FP		•	•	•	•	•	1"	120"	•	•	•
Flat TFE Teflon	FT		•	•	•	•	•	1"	120"	•	•	•
Individual PVC	IP	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large PVC	IPL	•	•	•	•	•	•	1"	48"	•	•	•
Individual Miniature PVC	IPM		•	•	•	•	•	1"	48"	•	•	•
Individual TFE Teflon	IT	•	•	•	•	•	•	1"	48"	•	•	•
Individual Large TFE Teflon	ITL	•	•	•	•	•	•	1'	48"	•	•	•
Individual Miniature TFE Teflon	ITM		•	•	•	•	•	1'	48"	•	•	•
Individual Varnish-Insulated	IV		•	•	•	•	•	0.5"	12"	•	•	•

Lead Colors Available

Black: Blk	Green: Grn
Brown: Brn	Blue: Blu
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SECTION 4

Technical Information

- Thermistor Theory
- How to Use Thermilinears
- Assuring Accurate Measurement
- Basic Thermilinear Applications
- Custom Thermilinear Ranges
- Resistance versus Temperature Tables
- Glossary

4

Thermistor Theory

NTC thermistor materials are prepared by heating mixtures of metal oxides to high temperatures so that the oxides combine chemically to form the spinel crystallographic structure. The name derives from the mineral spinel, $MgAl2O_4$, which has this particular structure. In this structure Mg occupies tetrahedral, or A sites in the crystal lattice and Al occupies octahedral, or B sites. This is a normal spinel, with one 2+ metal ion on the A site, two 3+ metal ions on the B sites and four oxygens. This is commonly written $Mg[Al2]O_4$, where the elements inside the bracket represent the B sites.

An inverse spinel has half the trivalent ion on the A sites and the divalent ion on the B sites, such as nickel ferrite, $Fe[NiFe]O_4$. Various degrees of inversion can occur depending on the metal ions, the temperature of reaction, and any annealing cycles to which the material was subjected. A common thermistor material is nickel manganite, a partially inverse spinel with manganese present on the B sites in 3+ and 4+ states.

These types of materials are referred to as valence controlled semiconductors. Conduction occurs when ions having multiple valence states occupy equivalent crystallographic sites. It must be the same element and differ in valence by one unit and occupy B sites. The conduction mechanism is a thermally activated electron hopping process, in which the electrons hop from one cation (Mn^{3+}) to another (Mn^{4+}) in the B lattice sites under the influence of a potential gradient across the material.

The conductivity is a product of charge density and mobility. Charge density is determined by the number of charge carries, the density of B sites, and the probability of a B site being active. The mobility is determined by the distance between nearest neighbor B sites, the activation energy (needed for the electron to move from one site to another), and a frequency factor (how often it tries to jump). Charge carries are also produced by other defects such as non-stoichiometry and grain boundaries.

By considering the effects of all the above factors, an expression for conductivity can be derived:

$$\sigma=\sigma_\infty \exp(-q/kT)$$

where σ_∞ is the infinite temperature conductivity (which includes consideration of charge density and mobility), -q is the activation energy, k is Boltzmann's constant, and T the absolute temperature. For thermistors, the resistivity σ (and hence resistance) is of more interest and the above becomes

$$\sigma= \sigma_\infty \exp(q/kT)$$

By replacing resistivity with resistance values and combining the activation energy and Boltzmann's constant terms, the familiar thermistor expression is obtained

$$R = A \exp(ß/T)$$

where A includes dimensional factors and infinite temperature resistance, B is the material constant beta and T is the absolute temperature.

One can determine the beta constant by measuring the resistance at two temperatures and using the above equation,

$$R_1/R_2 = e \exp(ß/T_1 - ß/T_2)$$
$$\ln(R_1/R_2) = ß(1/T_1 - 1/T_2)$$
$$ß = \ln(R_1/R_2) / (1/T_1 - 1/T_2)$$

The temperature coefficient of resistance α is determined by

$$\alpha = 1/R \, dR/dT$$

and is usually expressed in terms of % change in resistance per degree.

The coefficient of resistance and the material constant ß are related to each other by

$$\alpha = (-ß/T^2)$$

Beta and α are two different ways of expressing the same property.

Although the expression $R = A \exp(ß/T)$ gives good agreement with experiment over short temperature spans, a better method of interpolation over larger temperature ranges is necessary for accurate temperature measurements.

Thermistor accuracy depends on the precision and uncertainty of the calibration system used. The precision of the measurement statement, however, is in large part due to the method of approximation and interpolation. The approximation methods outlined below provide several choices for maximum simplicity while allowing for precise interpolation.

The following table shows several approximation methods, the applicable temperature range and range of deviation from nominal resistance.

Equation	Temperature Range	Deviation
$Ln(R_T) = \frac{A}{T}$	very small	–
$R_T = A\exp\left(\frac{B}{T}\right)$	-20 to +120°C	+0.94, -0.82°C
$R_T = A\exp\left(\frac{B}{T_1}+\frac{C}{T_2}\right)$	-20 to +120°C	+0.83, -0.067°C
$R_T = A\exp\left(\frac{B}{T_1}+\frac{C}{T_2}+\frac{D}{T_3}\right)$	-20 to +120°C	+0.028, -0.007°C

The Steinhart and Hart equation is an empirical expression that has been determined to be the best mathematical expression for the resistance-temperature relationship of a negative temperature coefficient thermistor. It is usually found explicit in T:

$$1/T = a + b\,(\text{Ln } R) + c\,(\text{Ln } R)^3 \qquad (1)$$

where: T = Kelvin units (°C + 273.15)
a,b,c = coefficients derived from measurement
Ln R = natural logarithm of resistance in ohms

To find a, b and c, measure a thermistor at three temperatures. The temperatures should be evenly spaced, and at least 10°C apart. Use the three temperatures and resistances to solve three simultaneous equations.

$$1/T_1 = a + b\,(\text{Ln } R_1) + c\,(\text{Ln } R_1)^3$$

$$1/T_2 = a + b\,(\text{Ln } R_2) + c\,(\text{Ln } R_2)^3$$

$$1/T_3 = a + b\,(\text{Ln } R_3) + c\,(\text{Ln} R_3)^3$$

The equations allow you to derive a, b and c for any temperature range. We have calculated these coefficients for the range 0 to 100°C with 50°C as the intermediate point. These are listed below for your use.

Coefficients derived from 0, 50 and 100°C catalog resistance

Thermistor type	25°C resistance	a	b	c
001A	100 Ω	0.0017709	0.0003406	1.479E-07
002A	300 Ω	0.0015632	0.0003108	9.747E-08
003A	1 KΩ	0.001313	0.0002906	1.023E-07
004	2252 Ω	0.0014733	0.0002372	1.074E-07
005	3 KΩ	0.0014051	0.0002369	1.019E-07
007	5 KΩ	0.001288	0.0002356	9.557E-08
017	6 KΩ	0.0012474	0.000235	9.466E-08
016	10 KΩ	0.0011303	0.0002339	8.863E-08
006	10 KΩ	0.0010295	0.0002391	1.568E-07
008	30 KΩ	0.0009354	0.0002211	1.275E-07
011	100 KΩ	0.0008253	0.0002045	1.144E-07
014	300 KΩ	0.0008207	0.0001848	1.014E-07
015	1 MEGΩ	0.0008142	0.000167	8.819E-08

Knowing a, b and c for the thermistor allows you to use the Steinhart and Hart equation in two ways. If resistance is known and temperature is desired, use equation (1) above. If the temperature is known and expected resistance is desired, use equation (2) below. Remember that T is in Kelvin units.

$$R = e^{\exp\left[\left(ß - (\alpha/2)\right)^{1/3} - \left(ß + (\alpha/2)\right)^{1/3}\right]} \qquad (2)$$

where

$$\alpha = \left(a - (1/T)\right)/c \quad \text{and} \quad ß = \left[\left(\frac{b}{3c}\right)^3 + \frac{\alpha^2}{4}\right]^{1/2}$$

The ability to precisely interpolate for a given temperature from measurements at known fixed-points depends in part on the closeness of those points. Fixed-points such as the water triple point, mercury triple point, gallium melting point and indium freezing point provide a solid basis for the interpolation. YSI continues to research the degree to which the Steinhart and Hart equation truly represents the negative temperature coefficient thermistor.

For practical reasons some of the R vs. T tables have small interpolation differences when random values from the tables are used in the above equations, particularly over large temperature spans.

BASIC Program Calculates Coefficients

This is a very tedious calculation, so this program is listed for you to use. It results in the coefficients a, b and c. It is written in BASIC for use with DOS 2.0 or higher.

```
20 READ R1, T1, R2, T2, R3, T3 : K =273.15
25 T1 = T1 + K
30 T2 = T2 + K
35 T3 = T3 + K
40 X1 = LOG (R1)
45 X2 = LOG (R2)
50 X3 = LOG (R3)
55 S= X1 - X2
60 U = X1 - X3: V=1/T1 - 1/T2 : W =1/T1 - 1/T3
65 C = (V - S*W/U)/((X1^3-X2^3)-S*(X1^3-X3^3)/U)
70 B = (V- C*(X1^3-X2^3))/S
75A = 1/T1 - C*X1^3-B*X1
80 LPRINT "A= ";A;"B= ";B ;"C= ";C
85 END
```

Enter data on line 100 as: R1, T1, R2, T2, R3, T3. For example, a YSI 44004 thermistor measured at 0, 40, and 70°C would result in resistances of 7355, 1200 and 394.5 ohms. The data line should look like this:

100 DATA 7355,0,1200,40,394.5,70

The printout should look like this:

A = 1.474079E-03
B = 2.370418E-04
C = 1.083981E-07

Spreadsheet Program

The following spreadsheet program allows calculation of the Steinhart and Hart coefficients, using three resistances at three temperatures. It calculates resistance, dR/dT or determines the temperature for a known resistance.

Labels start with an apostrophe (’). Brackets indicate data you must enter. Other cells are formulas.

```
B1: 'Temp.(C)
C1: 'Resistance
D1: 'T (K)
E1: 'ln(R)
A2: 'Low
B2: [Input low temperature in °C]
C2: [Input low temp. resistance in ohms]
D2: +B2+273.15
E2: @LN(C2)
A3: 'Mid
B3: [Input mid temperature in °C]
C3: [Input mid temp. resistance in ohms]
D3: +B3+273.15
E3: @LN(C3)
A4: 'High
B4: [Input high temperature in °C]
C4: [Input high temp. resistance in ohms]
D4: +B4+273.15
E4: @LN(C4)
A6: 'ln(R1)-ln(R2)
B6: +E2-E3
A7: 'ln(R1)-ln(R3)
B7: +E2-E4
A8: '(1/T1)-(1/T2)
B8: 1/D2-1/D3
A9: '(1/T1)-(1/T3)
B9: 1/D2-1/D4
A11: 'Coefficients: a=
B11: 1/D2-B13*E2^3-B12*E2
A12: 'b=
B12: (B8-B13*(E2^3-E3^3))/B6
A13: 'c=
B13: (B8-B6*B9/B7)/((E2^3-E3^3)-B6*(E2^3-E4^3)/B7)
A15: 'Solving for R, given T:
A16: 'Degrees C=
B16: [Input known temperature in °C]
C16: +B16+273.15
D16: (B11-(1/C16))/B13
E16: '=A
D17: @SQRT((B12/(3*B13))^3+(D16^2)/4)
E17: '=B
A18: 'Resistance (Ohm)=
B18: @EXP((D17-(D16/2))^(1/3)-(D17+(D16/2))^(1/3))
A19: 'dR/dT=
B19: -1*B18/(C16^2*(B12+3*B13*(@LN(B18))^2))
A20: '%dR/dT=
B20: +B19/B18*100
A23: 'Solving for T, given R:
A24: 'Ohms=
B24: [Input known resistance in ohms]
A26: 'Temperature (C)=
B26: 1/(B11+B12*@LN(B24)+B13*(@LN(B24))^3)-273.15
```

How to Use Thermilinears

We present a general description of Thermilinear networks in the Thermilinear Component Section of the catalog. The examples below describe general circuit development that may be used with YSI Thermilinear Networks.

Voltage Mode

You can develop a thermometer circuit without active circuitry using the voltage mode. The voltage mode configuration is based on a voltage divider (figure 1) or Wheatstone bridge (figure 2). We consider both circuits together in the following example since the bridge is an extension of the voltage divider.

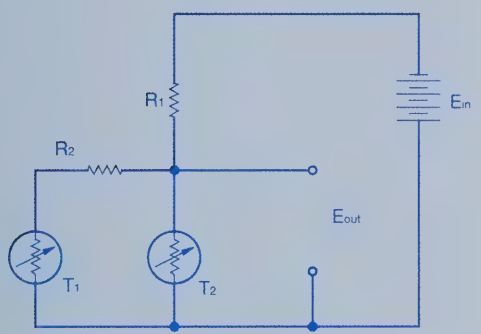

Figure 1

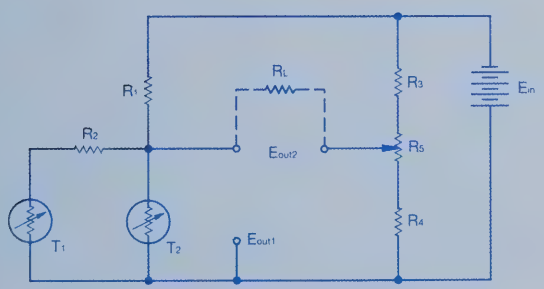

Figure 2

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Voltage Mode Circuit Design Example

The range and output slope must be established first. The signs and units must be known. The example will be:
range: 0 to 100°C
output slope: -10 mv/°C (negative slope)

We use the YSI 44201 network in the example. This network has a temperature range of 0 to 100°C, includes the YSI 44018 Thermilinear composite and the YSI 44301 resistor set. We've taken design data from YSI Thermilinear Network Specification pages.

$R_1 = 3200\ \Omega$
$R_2 = 6250\ \Omega$

$E_o = (-0.0053483E_{in})t + 0.86507E_{in}$

sensitivity constant
$= (\delta/\delta)/E_{in}$
$= -0.0053483$

output voltage at 0°C per volt in
$= E_{o0°C}/\delta E_{in}$
$= +0.86507$

$R_t = (-17.115)t + 2768.23$

$-\delta R$

R_t @ 0°C

1. Determine input voltage that results in the desired voltage sensitivity (-10mV/°C in this example). This is equal to the voltage sensitivity per degree divided by the sensitivity constant.

$E_{in} = (\delta E/\delta t)\ (\delta/\delta)/E_{in})$
$= -.01\ V/°C \div -0.0053483/°C$
$= 1.869753\ V$

2. Determine output voltage (E_{out}). The general equation is given with the temperature as the variable.

$E_{out} = [((\delta/\delta T)/E_{in}) \times E_{in}] \times t + (\delta E_{o0°C}/E_{in} \times E_{in})$

@ 0°C = -0.0053483/°C x 1.869753 V x 0°C + 0.86507 x 1.869753 V = 1.617467 V

@ 100°C = -0.0053483/°C x 1.869753 V x 100°C + 0.86507 x 1.869753 V = 0.617467 V

3. Power dissipation. Calculate self-heat to evaluate the effect of power on measurement accuracy. Self-heat is most severe for the higher resistance thermistor (T_2) at high temperature. A 30K Ω @ 25°C thermistor has a resistance of 2069 Ω at 100°C.

$P = E^2 \div R$

Where:

P = power dissipation in watts

E = voltage at the maximum temperature

R = resistance of the higher resistance thermistor at the maximum temperature

$P = 0.617467^2\ V \div 2069\ \Omega = 0.000184$ Watts

The dissipation constant is used to turn this into a temperature unit. We will assume for the example that the component is immersed in flowing water. The dissipation constant for a 44018 is 8 mW/°C (0.008W/°C) in flowing water.

Self-heat error = 0.000184 W ÷ 0.008W/°C
= 0.023°C

The resistors R_3, R_4 and R_5 are to be selected next. The goal is to pick these resistors to achieve 0 V out at 0°C. The first thing that must be done is to determine the resistance of T_1, R_2 and T_2 at 0°C. The total of these resistances will be called R_{cal}. $R_{cal.}$ will be calculated by first calculating the total resistance for the left half of the bridge, R_t and then subtracting the effect of R_1. For this example, the equation for R_t is found in the data table for the YSI 44201 network.

$R_t = (17.115\ \Omega/°C) \times t°C + 2768.23\ \Omega$

@ 0°C = (-17.115 Ω/°C) x 0°C + 2768.23 Ω
= 2768.23

@ 100°C = (-17.115 Ω/°C) x 100°C + 2768.23 Ω
= 1056.73

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Now R_{cal} is calculated with the following formula:

$$\frac{1}{R_{cal}} = \frac{1}{R_t} - \frac{1}{R_1}$$

$$\frac{1}{R_{cal@0°C}} = \frac{1}{R_{t@0°C}} - \frac{1}{R_1}$$

$$\frac{1}{R_{cal@0°C}} = \frac{1}{R_{t@0°C}} - \frac{1}{R_1}$$

For the example:

$$\frac{1}{R_{cal@0°C}} = \frac{1}{2768.23\ \Omega} \quad \frac{1}{3200\ \Omega} = 0.000048742$$

$R_{cal@0°C} = 1 / 0.000048742 = 20516.3\ \Omega$

A ratio calculation is done to determine the values for R3 and R4.

$$\frac{R_1}{R_{cal@0°C}} = \frac{R_3}{R_4}$$

Another resistor, R_5, is introduced at this time. This is the zero control. The total resistance of this resistor is to be equal to two times the tolerance of the larger of R_3 and R_4. When making circuit calculations, it is assumed that half of R_5's resistance is included with R_3 and the other half with R_4.

R_4 is chosen by the designer and R_3 is calculated based on the selection of R_4. For the example:

choose R_4 = 4990 ±1% (approximately ±50 Ω)

$R_5 = 2 \times 50 = 100$

$R_3 + R_5/2$ is substituted for R_3 in the ratio equation above.

$R_4 + R_5/2$ is substituted for R_4 in the ratio equation above.

Solve the ratio equation:

$R_3 = R_5/2 = [R_1 \times (R_4 + R_5/2)] / R_{cal0°C}$

$R_3 = [(R_1 \times (R_4 + R_5/2)) / R_{cal0°C}] - R_5/2$

$= [(3200\ \Omega \times (4990\ \Omega + 50\ \Omega))/20516.3\ \Omega] - 100/2$

$= 736.1\ \Omega$

A standard resistor value is selected that is near to this calculated value. 732 Ω is selected for the example.

The last step is to ascertain that the null value of the circuit falls within the adjustment range of the control.

$R_x = ((R_3 + R_4 + R_5) \times E_{out@0°}) - R_4$

Where:

R_x = the part of the control added to R_4. This is not to exceed $R_5/2$.

For the example:

$R_x = ((732 + 4990 + 100) \times 0.86507) - 4990$

$= 46.44\ \Omega$

Since $R_x \leq R_5/2$, the resistor selections are acceptable.

Resistive Mode Operations

Using the Thermilinear network in the resistive mode requires energizing the network with a constant current. This can be done by connecting the network in the feedback loop of an operational amplifier (below).

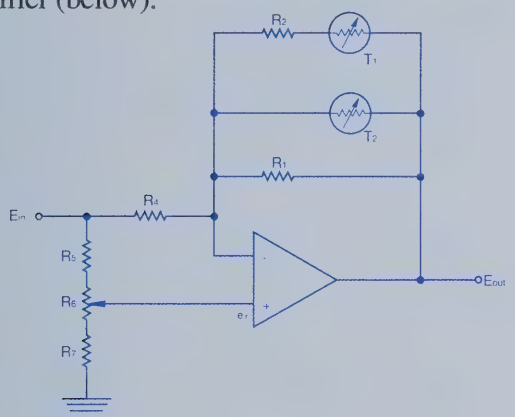

Figure 3

The general transfer function for this circuit is:

$$E_{out} = [1 + \frac{R_t}{R_4}]\, e_r - \frac{R_t}{R_4} E_{in}$$

Where: R_t = Resistance of the network in the resistive mode

(feedback resistance)

e_r = voltage at the positive input

As in the voltage mode, the range and output slope must be established. The signs and units must be known.

range: 30 to 100°F

output slope: -10mV/°C (negative slope)

We use the YSI 44204 network in the example. This network has a temperature range of 30 to 100°F, includes the YSI 44018 Thermilinear composite and the YSI 44304 resistor set. We've taken design data from YSI Thermilinear Network Specification pages.

R_4 must be calculated for this circuit. As seen in the equation above, zero output occurs when $R_t = R_4$ and $E_{in} = 2e_r$. Zero degrees can be placed at any reasonable point, either inside or outside the intended range of the circuit.

This example sets $R_4 = R_t$ at 0°F, which is outside the range. This means that the equation above may not be used, and the R_t equation must be used. The equation for the YSI 44204 network is:

$R_t = (-17.834)t + 5173.7$

$-\delta R$

R_t @ 0°F

since t = 0°F, $R_t = 5173.7\ \Omega = R_4$

R_5, R_6 and R_7 are selected to achieve a voltage divider so that e_r can be set at one half of E_{in}.

The value of E_{in} is given by:

$$E_{in} = \frac{2\delta E(R_t@0°F)}{\delta R}$$

Where: δE = The change in E_o per degree

δR = The change in network resistance per degree

substituting numbers from the example:

$$E_{in} = \frac{2 \times 0.01 \times 5173.7}{17.834}$$

$= 5.802$

Power Dissipation

A method to determine power dissipation is described in the voltage mode circuit design example.

The excitation voltage (E_{in}) must be stable for supply and temperature variations because the current requirement is constant in this example. A series variable resistance can be used for setting E_{in} to produce the correct full scale output.

Two-Wire System

A 3-wire sensor can be reduced to a 2-wire sensor (below) if R_2 is connected at the sensor end of the cable in either the voltage or resistive mode. Note R_1 is connected to the other end of the cable. Resistance errors due to very long leads may then be subtracted from R_1.

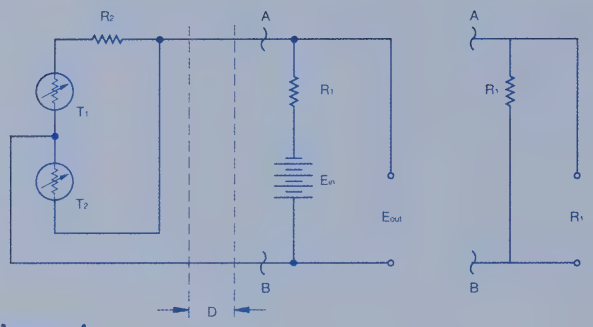

Figure 4

Multiplexing

One resistor set may serve any number of Thermilinear Composites for monitoring at several locations as shown below.

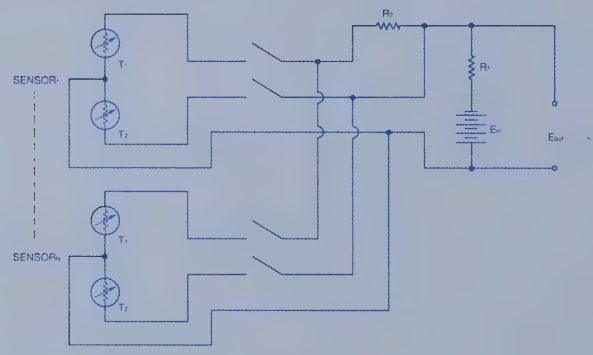

Figure 5

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Application Notes and Reprints

The application notes and reprints listed below are available from YSI Customer Service. Please order by number.

IA.05 Thermistor Equation with GE Basic Language
IA.06 Steinhart & Hart Thermistor Equation
IA.07 Thermistor Equation with MU BASIC Language
IA.08 National Bureau of Standards (NBS) Traceability at YSI for Thermistor Measurements
IA.13 Goddard Space Flight Specification GSFC S-311-P-18 for YSI Space-Qualified Thermistors
IA.15 Reproducibility, Stability and Linearization of Thermistor Resistance Thermometers
IA.18 Basic Concepts of Thermistors for Resistance Thermometry
IA.20 Aging Phenomena in Nickel-Manganese Oxide Thermistors
IA.21 Enhanced Stability in Precision Interchangeable Thermistors
IA.22 Practical Design Techniques Tame Thermistor Nonlinearities (from EDN, 1/20/83)
IA.29 Thermistor Equation with BASICA Language
IB.04 Special Range Designs for YSI 44018 Thermilinear Thermistors
IB.11 All About Thermistors (from Radio-Electronics, 1985)
IB.12 Thermistor Aging Phenomenon Due to Temperature Cycling

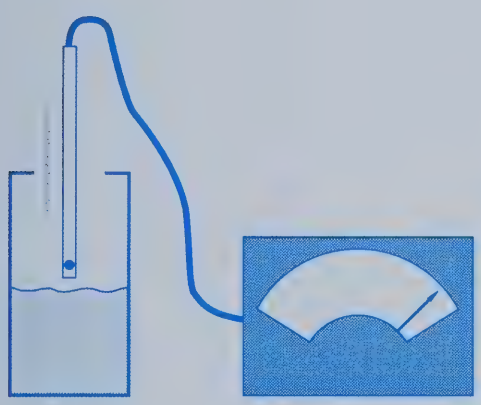
Assuring Accurate Measurement

You can ensure the accuracy of your measurement by avoiding the common errors explained below.

Immersion Stem Effect

An error source frequently ignored is stem effect. It can be the source of very large errors. Stem effect occurs when a portion of the probe is at a temperature other than the temperature of the sample.

Here's a simple method for determining stem effect. Slowly insert the probe in a sample at approximately the test temperature while observing the readout to determine when there's no further change with further insertion. When no further change is observed, stem effect error eliminated.



How to Eliminate Immersion Stem Effect

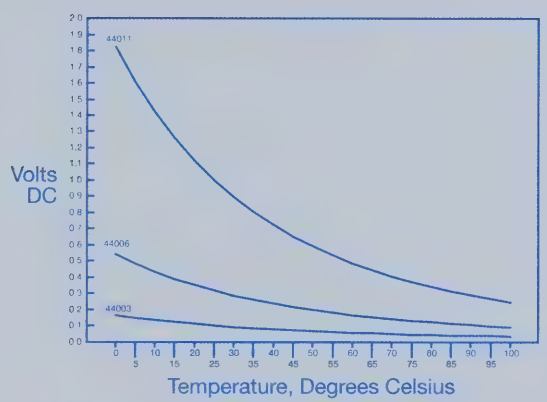
1. Immersion should be at least 10 times the diameter of the probe.

2. The sample volume should be no less than 1,000 times the mass of the sensor.

Dissipation Error (Self-Heat)

Power application to a thermistor may induce a temperature change in the sensor. This change is called dissipation or self-heat error. You may reduce dissipation error by limiting the power applied to a thermistor during a measurement.

The graph below illustrates the relationship between voltage, temperature and self-heat for a thermistor component in still air (1 mW/°C dissipation). The lines represent 10 mK of self-heat for YSI 44003A, 44006, 44011 Thermistors.



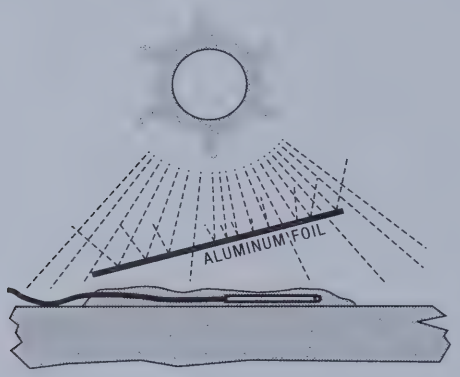
Gas Stream Error

A major source of error in the measurement of low-flow gas streams is another sort of stem effect. In this case, the leads conduct better than the sample and transfer heat to the thermistor. Mounting the thermistor on its own leads and having as much of the leads exposed to the sample as possible will improve the accuracy of the measurement. A very low mass form for lead support exposes a greater length of lead to the sample.

In still air, self-heat from over application of power to the thermistor can contribute significantly to the error. If the thermistor is self-heated, any change in air flow will change its resistance and its apparent temperature.

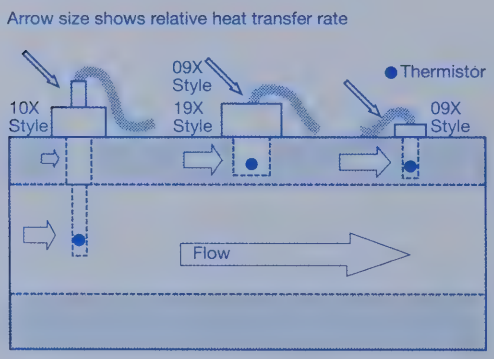
Radiant Error

Radiant energy directed on the sensor, may cause radiant error. This error, similar to stem effect, is common and significant when measuring in direct sunlight or other radiant source. Inserting a reflective surface between the radiant source and the sensor-lead combination reduces error.



Pipe Error

Pipe error may occur if a significant temperature differential exists between the pipe wall and the fluid or gas. Flow rate and immersion depth of the probe will significantly affect the accuracy of the measurement. The drawing below illustrates this effect. The two probes on the right are measuring pipe temperature; the probe on the left is measuring the temperature of the flow.



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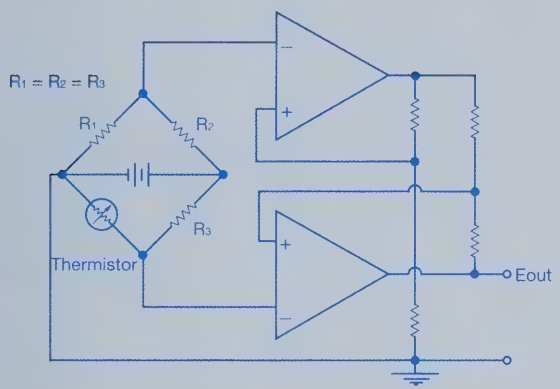
Basic Thermistor Applications

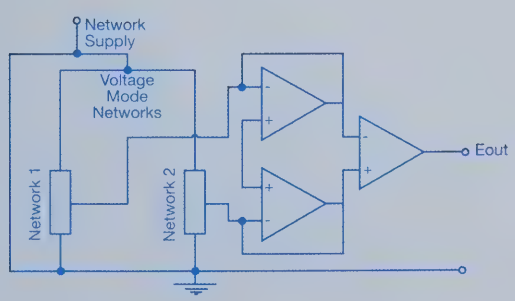
Wheatstone Bridge Null Detector

The Wheatstone bridge is a null detection measurement system. To detect deviation, assuming no load, pick components creating a parallel voltage divider. R_1 and R_t are one side and R_2 and R_3 the other. For a balanced bridge configuration R_1, R_2 and R_3 are equal and have a value equal to the midpoint of the thermistor resistance for the range chosen. Utilizing op amps for the detector circuit, it's possible to detect millidegree changes in temperature.



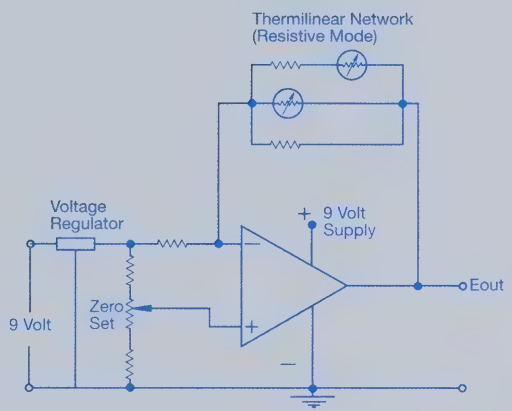
Thermilinear Differential Amplifier

This circuit uses two Thermilinear networks to measure differential temperature. This design provides very high sensitivity for calorimetry and thermal flow analyzers. With the addition of a heat source, the circuit may be used for determining groundwater flow rate and direction. For further circuit design ideas, refer to RCA Solid State Linear Data Book, CA3240A.



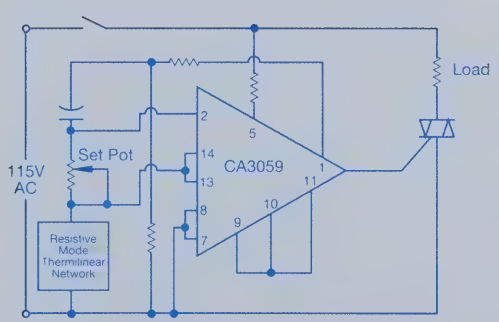
Millivolt Temperature Indicator

This circuit provides a linear voltage output corresponding to temperature. The supply may be 7 to 36 VDC. A 9 V alkaline battery allows 100 hours of operation. The circuit uses micropower op amps such as the CA3140A. Amplifier design detail is available in the RCA Solid State, Linear Design Manual.



Triac Temperature Controller

This design is a very-low-component-count zero crossing triac temperature controller. It allows use of a multiturn pot as the setting device. The setting pot can be scaled to be direct-reading in temperature using series and parallel resistors. A zero crossing switch significantly reduces noise on the controlled line. For further design information, refer to RCA Solid State Linear Data Book, CA3059A.



Custom Thermilinear Ranges

This page and the next list Thermilinear ranges developed for custom applications. Below are ranges developed for applications in °C. The following page shows ranges developed for applications in °F. Please note that the user supplies range resistors.

Custom Thermilinear Ranges in °C

No.	Temperature Range °C	Linearity Deviation °C	R_1	R_2	R_t Variables Slope (m)	Intercept (b)	E_{out} Variables Slope (m)	Intercept (b)
1	-40 to +70	1.20	17290	35250	-112.6240	11457.50	-0.0065138	0.662664
2	-30 to +50	0.16	18700	35250	-127.0960	12175.00	-0.0067965	0.651070
3	-30 to +55	0.31	18900	37000	-128.3340	12326.50	-0.0067902	0.651290
4	-30 to +60	0.37	14000	25500	-91.2740	9626.57	-0.0065196	0.687610
5	-30 to +70	0.96	14500	30000	-94.4784	10013.90	-0.0065158	0.690610
6	-25 to +55	0.20	16000	31000	-106.6430	10786.10	-0.0066652	0.674130
7	-5 to +45	0.06	5700	12000	-32.4020	4593.39	-0.0056846	0.805858
8	-5 to +50	0.08	5690	11600	-32.6089	4577.55	-0.0057309	0.804490
9	-5 to +125	1.11	2610	5230	-13.3552	2304.34	-0.0051169	0.882889
10	-2 to +38	0.03	5700	12400	-32.1012	4603.11	-0.0056318	0.807563
11	0 to 10	0.00	42000	67900	-310.7530	21849.50	-0.0073988	0.520226
12	0 to 30	0.04	11680	22960	-73.8485	8358.02	-0.0063226	0.715584
13	0 to 40	0.27	5900	12400	-28.5226	4442.72	-0.0048347	0.753067
14	0 to 60	0.14	7775	14800	-47.0450	5938.37	-0.0060508	0.763770
15	0 to 100	0.22	3200	6250	-17.1150	2768.23	-0.0053483	0.865070
16	0 to 120	0.81	2610	5230	-13.3552	2304.34	-0.0051169	0.882889
17	5 to 130	0.88	2130	4635	-10.6233	1936.67	-0.0049874	0.909235
18	15 to 35	0.01	4400	10100	-23.5611	3687.77	-0.0053547	0.838130
19	15 to 45	0.03	4380	9450	-23.8370	3660.60	-0.0054422	0.835753
20	15 to 65	0.07	6739	12252	-39.8117	5225.63	-0.0059080	0.775471
21	20 to 32	0.00	4400	10100	-23.5181	3686.65	-0.0053450	0.837875
22	20 to 65	0.06	2500	5360	-12.6473	2234.19	-0.0050589	0.893676
23	20 to 120	0.23	1696	3383	-8.2913	1577.55	-0.0048887	0.930159
24	22 to 42	0.02	5445	10800	-30.8702	4388.70	-0.0056694	0.806006
25	28 to 64	0.04	1900	4300	-9.1144	1750.58	-0.0047970	0.921358
26	35 to 135	0.27	1175	2375	-5.4353	1133.10	-0.0046257	0.964340
27	45 to 75	0.04	2000	3900	-9.8670	1816.00	-0.0049335	0.908000
28	45 to 125	0.19	1030	2050	-4.6619	1002.50	-0.0045261	0.973301
29	50 to 100	0.05	2500	4530	-12.8234	2202.82	-0.0051294	0.881120
30	55 to 65	0.00	2000	3900	-9.8319	1813.85	-0.0049159	0.906924

Custom Thermilinear Ranges in °F

No.	Temperature Range °F	Linearity Deviation °F	R_1	R_2	R_t Variables Slope (m)	R_t Variables Intercept (b)	E_{out} Variables Slope (m)	E_{out} Variables Intercept (b)
1	-35 to +135	1.29	20000	37000	-75.5000	15225.00	-0.0037750	0.761250
2	-32 to +32	0.07	40000	80000	-164.1970	27194.80	-0.0041049	0.679870
3	-22 to +78	0.20	45200	85200	-191.1050	29777.50	-0.0042280	0.658794
4	-20 to +150	1.04	13000	24500	-46.7096	10582.20	-0.0035930	0.814014
5	-15 to +145	0.55	13000	24500	-46.7096	10582.20	-0.0035930	0.814014
6	-10 to +40	0.14	62500	110000	-272.7200	37929.00	-0.0043635	0.606864
7	0 to 50	0.07	59710	30800	-122.8300	21911.00	-0.0039879	0.711396
8	0 to 100	0.26	18700	35250	-70.7303	14442.10	-0.0037824	0.772305
9	0 to 150	0.40	10000	19000	-34.7982	8450.15	-0.0034798	0.845015
10	0 to 160	0.64	8277.5	15471	-28.0207	7148.16	-0.0038516	0.863563
11	0 to 200	1.72	5875	11300	-18.8904	5282.29	-0.0032154	0.899113
12	5 to 190	0.88	5875	11300	-18.8904	5282.29	-0.0032154	0.899113
13	20 to 60	0.03	37200	18600	-69.0605	14423.20	-0.0037129	0.775441
14	20 to120	0.19	6500	13000	-21.1800	5802.00	-0.0032585	0.892615
15	20 to 200	0.48	4500	8800	-14.0129	4175.26	-0.0031140	0.927836
16	28 to 248	1.47	2610	5230	-7.4195	2541.76	-0.0028427	0.973856
17	35 to 110	0.14	5700	12000	-17.9774	5168.05	-0.0031539	0.906675
18	40 to 140	0.17	3861	7900	-11.6765	3646.52	-0.0030242	0.944500
19	45 to 85	0.01	5500	12650	-16.8395	5017.19	-0.0030617	0.912216
20	60 to 110	0.05	4380	9525	-13.2020	4084.02	-0.0030142	0.932425
21	60 to 160	0.22	3100	6250	-9.1044	2987.45	-0.0029369	0.963694
22	60 to 240	0.39	1696	3383	-4.6020	1724.31	-0.0027135	1.016690
23	75 to 125	0.03	3160	6900	-9.1003	3040.84	-0.0028798	0.962292
24	79 to 103	0.01	6000	11350	-19.1722	5357.35	-0.0031954	0.892892
25	80 to 120	0.03	3500	7400	-10.2679	3330.22	-0.0029337	0.951491
26	80 to 180	0.17	3704	6843	-11.1928	3482.68	-0.0030218	0.940248
27	80 to 260	0.49	1425	2875	-3.7716	1470.15	-0.0026463	1.031680
28	88 to 108	0.01	5900	11000	-18.8379	5271.65	-0.0031929	0.893500
29	100 to 140	0.03	5576	2788	-7.9933	2701.95	-0.0028672	0.969191
30	100 to 150	0.03	1610	3700	-4.1642	1640.74	-0.0025865	1.019090
31	100 to 200	0.19	2300	4300	-6.4888	2261.46	-0.0028212	0.983242
32	110 to 160	0.04	2000	4060	-5.4584	1996.05	-0.0027292	0.998024
33	135 to 185	0.01	2300	3945	-6.4270	2232.67	-0.0027944	0.970724
34	200 to 300	0.13	425	800	-0.9221	468.42	-0.0021696	1.102170
35	205 to 270	0.03	830	1500	-2.0006	876.12	-0.0024103	1.055570

4

Call us to discuss your application at
800 765-4974. Fax 513 767-9353

Resistance versus Temperature -80 to -11°C

YSI Thermistor				45004 46004 46033 46043	45005 46005 46030 46040	45007 46007 46034 46044	45017 46017 46037 46047	45016 46016 46036 46046	45006 46006 46031 46041	45008 46008 46032			
	44001A 44101A	44002A 44102A	44003A 44103A	44004 44104A	44005 44105A	44007 44107A	44017 44117A	44016 44116A	44006 44106A	44008 44108A	44011	44014	44015
Ω 25°C °C	100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
-80	14.47K	67.66K	278.8K	1660K	2211K	3685K	4423K	7371K	3558K				
79	13.51K	62.78K	258.1K	1518K	2022K	3371K	4044K	6741K	3296K				
78	12.62K	58.29K	239.1K	1390K	1851K	3086K	3703K	6172K	3055K				
77	11.80K	54.15K	221.7K	1273K	1696K	2827K	3392K	5653K	2833K				
76	11.04K	50.34K	205.6K	1167K	1555K	2592K	3109K	5182K	2629K				
75	10.33K	46.83K	190.8K	1071K	1426K	2378K	2853K	4756K	2440K				
74	9672	43.58K	177.2K	982.8K	1309K	2182K	2618K	4364K	2266K				
73	9061	40.59K	164.7K	902.7K	1202K	2005K	2405K	4008K	2106K				
72	8494	37.82K	153.1K	829.7K	1105K	1843K	2211K	3684K	1957K				
71	7966	35.26K	142.5K	763.1K	1016K	1695K	2033K	3389K	1821K				
-70	7475	32.9K	132.6K	702.3K	935.4K	1560K	1871K	3119K	1694K				
69	7018	30.71K	123.5K	646.7K	861.4K	1436K	1723K	2872K	1577K				
68	6592	28.68K	115.1K	595.9K	793.7K	1323K	1588K	2646K	1469K				
67	6195	26.8K	107.3K	549.4K	731.8K	1220K	1464K	2440K	1369K				
66	5825	25.06K	100.1K	506.9K	675.2K	1126K	1351K	2251K	1276K				
65	5479	23.45K	93.48K	467.9K	623.3K	1039K	1247K	2078K	1190K				
64	5157	21.95K	87.3K	432.2K	575.7K	959.9K	1152K	1919K	1111K				
63	4856	20.55K	81.58K	399.5K	532.1K	887.2K	1064K	1774K	1037K				
62	4575	19.26K	76.28K	369.4K	492.1K	820.5K	984.2K	1640K	968.4K				
61	4312	18.05K	71.35K	341.8K	455.3K	759.2K	910.7K	1518K	904.9K				
-60	4066	16.93K	66.78K	316.5K	421.5K	702.9K	843.3K	1405K	845.9K				
59	3835	15.89K	62.53K	293.2K	390.5K	651.1K	781.2K	1302K	791.1K				
58	3620	14.92K	58.59K	271.7K	361.9K	603.5K	723.9K	1206K	740.2K				
57	3418	14.02K	54.92K	252K	335.7K	559.7K	671.4K	1119K	692.8K				
56	3229	13.17K	51.5K	233.8K	311.5K	519.4K	622.9K	1038K	648.8K				
55	3051	12.39K	48.32K	217.1K	289.2K	482.2K	578.4K	964K	607.8K				
54	2885	11.65K	45.36K	201.7K	268.6K	447.9K	537.4K	895.6K	569.6K				
53	2729	10.97K	42.6K	187.4K	249.7K	416.3K	499.3K	832.1K	534.1K				
52	2582	10.33K	40.03K	174.3K	232.2K	387.1K	464.4K	774K	501K				
51	2445	9730	37.63K	162.2K	216K	360.2K	432.1K	720.2K	470.1K				
-50	2315	9171	35.39K	151K	201.1K	335.3K	402.3K	670.5K	441.3K				
49	2194	8647	33.3K	140.6K	187.3K	312.3K	374.6K	670.5K	414.5K				
48	2079	8158	31.35K	131K	174.5K	291K	349K	624.3K	389.4K				
47	1972	7699	29.52K	122.1K	162.7K	271.3K	325.3K	581.7K	366K				
46	1870	7270	27.81K	113.9K	151.7K	253K	303.5K	542.2K	344.1K				
45	1775	6867	26.22K	106.3K	141.6K	236.2K	283.2K	440.8K	323.7K				
44	1685	6489	24.72K	99.26K	132.2K	220.5K	264.5K	472K	304.6K				
43	1600	6135	23.32K	92.72K	123.5K	205.9K	247K	411.7K	286.7K				
42	1521	5803	22.01K	86.65K	115.4K	192.5K	230.9K	384.8K	270K				
41	1445	5491	20.79K	81.02K	107.9K	180K	215.9K	359.8K	254.4K				
-40	1374	5198	19.64K	75.79K	101K	168.3K	201.9K	336.5K	239.8K	884.6K	3356K		
39	1307	4922	18.56K	70.93K	94.48K	157.5K	189K	315K	226K	830.9K	3147K		
38	1244	4663	17.54K	66.41K	88.46K	147.5K	176.9K	294.9K	213.2K	780.8K	2951K		
37	1184	4420	16.59K	62.21K	82.87K	138.2K	165.7K	276.2K	201.1K	733.9K	2769K		
36	1127	4191	15.7K	58.3K	77.66K	129.5K	155.3K	258.9K	189.8K	690.2K	2599K		
35	1073	3975	14.86K	54.66K	72.81K	121.4K	145.6K	242.7K	179.2K	649.3K	2440K		
34	1023	3772	14.07K	51.27K	68.3K	113.9K	136.6K	227.7K	169.3K	611K	2292K		
33	974.9	3580	13.33K	48.11K	64.09K	106.9K	128.2K	213.6K	160K	575.2K	2154K		
32	929.6	3400	12.63K	45.17K	60.17K	100.3K	120.3K	200.6K	151.2K	541.7K	2025K		
31	886.6	3230	11.97K	42.42K	56.51K	94.22K	113K	188.4K	143K	510.4K	1904K		
-30	846.0	3069	11.35K	39.86K	53.1K	88.53K	106.2K	177K	135.2K	481K	1791K		
29	807.5	2918	10.77K	37.47K	49.91K	83.22K	99.83K	166.4K	127.9K	453.5K	1685K		
28	771.0	2775	10.22K	35.24K	46.94K	78.26K	93.89K	156.5K	121.1K	427.7K	1586K		
27	736.4	2640	9705	33.15K	44.16K	73.62K	88.32K	147.2K	114.6K	403.5K	1494K		
26	703.6	2512	9218	31.2K	41.56K	69.29K	83.13K	138.5K	108.6K	380.9K	1407K		
25	672.5	2392	8758	29.38K	39.13K	65.24K	78.28K	130.5K	102.9K	359.6K	1326K		
24	643.0	2278	8323	27.67K	36.86K	61.45K	73.72K	122.9K	97.49K	339.6K	1250K		
23	614.9	2170	7914	26.07K	34.73K	57.9K	69.46K	115.8K	92.43K	320.9K	1178K		
22	588.3	2068	7527	24.58K	32.74K	54.58K	65.49K	109.1K	87.66K	303.3K	1111K		
21	563.0	1972	7161	23.18K	30.87K	51.47K	61.76K	102.9K	83.16K	286.7K	1049K		
-20	538.9	1880	6815	21.87K	29.13K	48.56K	58.27K	97.11K	78.91K	271.2K	989.8K		
19	516.1	1794	6489	20.64K	27.49K	45.83K	54.99K	91.65K	74.91K	256.5K	934.6K		
18	494.3	1712	6180	19.48K	25.95K	43.27K	51.9K	86.5K	71.13K	242.8K	882.7K		
17	473.6	1634	5887	18.4K	24.51K	40.86K	49.02K	81.71K	67.57K	229.8K	834K		
16	454.0	1561	5611	17.39K	23.16K	38.61K	46.33K	77.22K	64.2K	217.6K	788.2K		
15	435.2	1491	5349	16.43K	21.89K	36.49K	43.77K	72.96K	61.02K	206.2K	745.2K		
14	417.4	1424	5101	15.54K	20.7K	34.5K	41.4K	69.01K	58.01K	195.4K	704.7K		
13	400.4	1361	4866	14.7K	19.58K	32.63K	39.17K	65.28K	55.17K	185.2K	666.7K		
12	384.2	1302	4643	13.91K	18.52K	30.88K	37.06K	61.77K	52.48K	175.6K	630.9K		
11	368.8	1245	4432	13.16K	17.53K	29.23K	35.06K	58.44K	49.94K	166.6K	597.2K		

Resistance versus Temperature -10 to +59°C

YSI Thermistor				45004 46004 46033 46043	45005 46005 46030 46040	45007 46007 46034 46044	45017 46017 46037 46047	45016 46016 46036 46046	45006 46006 46031 46041	45008 46008 46032			
	44001A 44101A	44002A 44102A	44003A 44103A	44004 44104A	44005 44105A	44007 44107A	44017 44117A	44016 44116A	44006 44106A	44008 44108A	44011	44014	44015
Ω 25°C °C	**100**	**300**	**1000**	**2252**	**3000**	**5000**	**6000**	**10,000**	**10,000**	**30,000**	**100,000**	**300,000**	**1 MEG**
-10	354.1	1191	4232	12.46K	16.60K	27.67K	33.20K	55.33K	47.54K	158K	565.5K		
9	340.0	1140	4042	11.81K	15.72K	26.21K	31.47K	52.44K	45.27K	150K	535.6K		
8	326.7	1091	3862	11.19K	14.90K	24.83K	29.81K	49.69K	43.11K	142.4K	507.5K		
7	313.9	1045	3691	10.60K	14.12K	23.54K	28.24K	47.07K	41.07K	135.2K	481K		
6	301.7	1001	3529	10.05K	13.39K	22.32K	26.78K	44.63K	39.14K	128.5K	456K		
5	290.1	958.9	3374	9.530K	12.70K	21.17K	25.40K	42.34K	37.31K	122.1K	432.4K		
4	278.9	919.0	3228	9.050K	12.05K	20.08K	24.10K	40.17K	35.57K	116K	410.2K		
3	268.3	881.0	3088	8.590K	11.44K	19.06K	22.88K	38.13K	33.93K	110.3K	389.2K		
2	258.2	844.8	2956	8.150K	10.86K	18.10K	21.72K	36.19K	32.37K	104.9K	369.4K		
-1	248.5	810.3	2830	7.741K	10.31K	17.19K	20.62K	34.37K	30.89K	99.80K	350.7K		
0	239.2	777.5	2710	7355	9796	16.33K	19.60K	32.66K	29.49K	94.98K	333.1K	1088K	3966K
+1	230.3	746.2	2596	6989	9310	15.52K	18.62K	31.03K	28.15K	90.41K	316.4K	1030K	3740K
2	221.9	716.3	2487	6644	8851	14.75K	17.70K	29.50K	26.89K	86.09K	300.6K	975.3K	3529K
3	213.8	687.8	2384	6319	8417	14.03K	16.84K	28.06K	25.69K	81.99K	285.7K	923.8K	3330K
4	206.0	660.6	2286	6011	8006	13.34K	16.02K	26.69K	24.55K	78.11K	271.6K	875.2K	3144K
5	198.6	634.6	2192	5719	7618	12.70K	15.24K	25.40K	23.46K	74.44K	258.3K	829.5K	2969K
6	191.5	609.9	2102	5444	7252	12.09K	14.50K	24.17K	22.43K	70.96K	245.7K	786.3K	2804K
7	184.6	586.2	2017	5183	6905	11.51K	13.81K	23.02K	21.45K	67.66K	233.8K	745.6K	2649K
8	178.1	563.6	1936	4937	6576	10.96K	13.15K	21.92K	20.52K	64.53K	222.5K	707.2K	2504K
9	171.9	542.1	1859	4703	6265	10.44K	12.53K	20.88K	19.63K	61.56K	211.9K	671K	2367K
10	165.9	521.5	1785	4482	5971	9951	11.94K	19.90 K	18.79K	58.75K	201.7K	636.8K	2238K
11	160.1	501.7	1714	4273	5692	9486	11.38K	18.97K	17.98K	56.07K	192.2K	604.5K	2117K
12	154.6	482.9	1647	4074	5427	9046	10.85K	18.09K	17.22K	53.54K	183.1K	574K	2003K
13	149.3	464.9	1582	3886	5177	8628	10.35K	17.26K	16.49K	51.13K	174.5K	545.2K	1896K
14	144.2	447.6	1521	3708	4939	8232	9879	16.47K	15.79K	48.84K	166.3K	518K	1795K
15	139.4	431.2	1462	3539	4714	7857	9429	15.71K	15.13K	46.67K	158.6K	492.3K	1700K
16	134.7	415.4	1406	3378	4500	7500	9000	15K	14.50K	44.60K	151.3K	468K	1610K
17	130.2	400.2	1353	3226	4297	7162	8595	14.33K	13.90K	42.64K	144.3K	444.9K	1525K
18	125.9	385.8	1302	3081	4105	6841	8209	13.68K	13.33K	40.77K	137.7K	423.2K	1446K
19	121.7	371.9	1253	2944	3922	6536	7844	13.07K	12.79K	38.99K	131.4K	402.6K	1370K
20	117.7	358.6	1206	2814	3748	6247	7497	12.5 0K	12.26K	37.30K	125.5K	383.1K	1299K
21	113.9	345.9	1161	2690	3583	5972	7167	11.94K	11.77K	35.70K	119.8K	364.6K	1232K
22	110.2	333.7	1118	2572	3426	5710	6853	11.42K	11.29K	34.17K	114.5K	347.1K	1169K
23	106.7	322.0	1077	2460	3277	5462	6554	10.92K	10.84K	32.71K	109.4K	330.6K	1110K
24	103.3	310.8	1038	2354	3135	5225	6272	10.45K	10.41K	31.32K	104.5K	314.9K	1053K
25	**100.0**	**300.0**	**1000**	**2252**	**3000**	**5000**	**6000**	**10K**	**10K**	**30K**	**100K**	**300K**	**1000K**
26	96.9	289.7	963.9	2156	2872	4787	5744	9574	9605	28.74K	95.51K	285.9K	949.7K
27	93.8	279.8	929.4	2064	2750	4583	5499	9165	9227	27.54K	91.34K	272.5K	902.2K
28	90.9	270.3	896.3	1977	2633	4389	5267	8779	8867	26.4K	87.38K	259.8K	857.2K
29	88.1	261.1	864.5	1894	2523	4204	5046	8410	8523	25.31K	83.6K	247.8K	814.7K
30	85.4	252.4	834.0	1815	2417	4029	4836	8060	8194	24.27K	80K	236.4K	774.5K
31	82.8	243.9	804.8	1739	2317	3861	4633	7722	7880	23.28K	76.58K	225.6K	736.5K
32	80.3	235.9	776.8	1667	2221	3702	4441	7402	7579	22.33K	73.32K	215.3K	700.5K
33	77.8	228.1	749.9	1599	2130	3549	4260	7100	7291	21.43K	70.22K	205.5K	666.4K
34	75.5	220.6	724.1	1533	2042	3404	4084	6807	7016	20.57K	67.26K	196.2K	634.1K
35	73.2	213.4	699.4	1471	1959	3266	3919	6532	6752	19.74K	64.44K	187.4K	603.6K
36	71.1	206.5	675.6	1412	1880	3134	3762	6270	6500	18.96K	61.75K	179K	574.6K
37	69.0	199.8	652.7	1355	1805	3008	3610	6017	6258	18.21K	59.19K	171K	547.2K
38	67.0	193.4	630.8	1301	1733	2888	3466	5777	6026	17.49K	56.75K	163.5K	521.2K
39	65.0	187.3	609.7	1249	1664	2773	3328	5546	5805	16.8K	54.42K	156.3K	496.6K
40	63.1	181.4	589.5	1200	1598	2663	3197	5329	5592	16.15K	52.19K	149.4K	473.2K
41	61.3	175.7	570.0	1152	1535	2559	3069	5116	5389	15.52K	50.07K	142.9K	451K
42	59.6	170.2	551.2	1107	1475	2459	2949	4916	5193	14.92K	48.04K	136.7K	430K
43	57.9	164.9	533.2	1064	1418	2363	2835	4725	5006	14.35K	46.11K	130.8K	410K
44	56.2	159.8	515.9	1023	1363	2272	2726	4543	4827	13.8K	44.26K	125.1K	391.1K
45	54.7	154.9	499.2	983.8	1310	2184	2621	4369	4655	13.28K	42.5K	119.8K	373.1K
46	53.1	150.1	483.2	946.2	1260	2101	2521	4202	4489	12.77K	40.81K	114.7K	356.1K
47	51.7	145.6	467.8	910.2	1212	2021	2425	4042	4331	12.29K	39.2K	109.8K	339.8K
48	50.2	141.2	452.9	875.8	1167	1944	2333	3889	4179	11.83K	37.66K	105.2K	324.4K
49	48.9	137.0	438.6	842.8	1123	1871	2246	3743	4033	11.39K	36.19K	100.8K	309.8K
50	47.5	132.9	424.8	811.3	1081	1801	2162	3603	3893	10.97K	34.78K	96.54K	295.9K
51	46.2	128.9	411.6	781.1	1040	1734	2081	3469	3758	10.57K	33.44K	92.52K	282.7K
52	45.0	125.1	398.8	752.2	1002	1670	2004	3340	3629	10.18	32.15K	88.69K	270.1K
53	43.8	121.5	386.5	724.5	965.0	1608	1930	3217	3504	9807	30.92K	85.04K	258.1K
54	42.6	117.9	374.7	697.9	929.6	1549	1859	3099	3385	9450	29.74K	81.55K	246.7K
55	41.5	114.5	363.2	672.5	895.8	1493	1792	2986	3270	9109	28.61K	78.22K	235.9K
56	40.4	111.2	352.2	648.1	863.3	1439	1727	2878	3160	8781	27.53K	75.04K	225.6K
57	39.3	108.0	341.6	624.8	832.2	1387	1665	2774	3054	8467	26.5K	72.01K	215.8K
58	38.3	105.0	331.3	602.4	802.3	1337	1605	2675	2952	8166	25.5K	69.11K	206.4K
59	37.3	102.0	321.5	580.9	773.7	1290	1548	2580	2854	7876	24.56K	66.34K	197.5K

Resistance versus Temperature 60 to 129°C

YSI Thermistor				45004 46004 46033 46043	45005 46005 46030 46040	45007 46007 46034 46044	45017 46017 46037 46047	45016 46016 46036 46046	45006 46006 46031 46041	45008 46008 46032			
	44001A 44101A	44002A 44102A	44003A 44103A	44004 44104A	44005 44105A	44007 44107A	44017 44117A	44016 44116A	44006 44106A	44008 44108A	44011	44014	44015
Ω 25°C °C	100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
60	36.4	99.1	311.9	560.3	746.3	1244	1493	2488	2760	7599	23.65K	63.7K	189.1K
61	35.4	96.3	302.7	540.5	719.9	1200	1440	2400	2669	7332	22.77K	61.17K	181K
62	34.5	93.7	293.9	521.5	694.7	1158	1389	2316	2582	7076	21.94K	58.75K	173.3K
63	33.7	91.1	285.3	503.3	670.4	1117	1341	2235	2497	6830	21.14K	56.44K	166K
64	32.8	88.6	277.0	485.8	647.1	1079	1294	2157	2417	6594	20.37K	54.23K	159K
65	32.0	86.1	269.0	469.0	624.7	1041	1250	2083	2339	6367	19.63K	52.12K	152.3K
66	31.2	83.8	261.3	452.9	603.3	1006.0	1207	2011	2264	6149	18.93K	50.1K	146K
67	30.4	81.5	253.9	437.4	582.6	971.1	1165	1942	2191	5940	18.25K	48.17K	139.9K
68	29.7	79.3	246.7	422.5	562.8	938.0	1126	1876	2122	5738	17.6K	46.32K	134.1K
69	29.0	77.2	239.7	408.2	543.7	906.3	1088	1813	2055	5545	16.97K	44.54K	128.6K
70	28.3	75.2	233.0	394.5	525.4	875.7	1051	1752	1990	5359	16.37K	42.85K	123.3K
71	27.6	73.2	226.5	381.2	507.8	846.4	1016	1693	1928	5180	15.8K	41.23K	118.3K
72	26.9	71.3	220.2	368.5	490.9	818.3	981.8	1636	1868	5007	15.25K	39.67K	113.5K
73	26.3	69.4	214.1	356.2	474.7	791.2	949.0	1582	1810	4842	14.72K	38.18K	108.9K
74	25.6	67.6	208.3	344.5	459.0	765.1	917.9	1530	1754	4682	14.21K	36.75K	104.5K
75	25.0	65.9	202.6	333.1	444.0	740.0	887.5	1479	1700	4529	13.72K	35.39K	100.3K
76	24.5	64.2	197.1	322.3	429.5	715.9	858.7	1431	1648	4381	13.25K	34.08K	96.31K
77	23.9	62.5	191.8	311.8	415.6	692.7	830.7	1385	1598	4239	12.79K	32.82K	92.48K
78	23.3	60.9	186.7	301.7	402.2	670.3	803.8	1340	1549	4102	12.36K	31.62K	88.82K
79	22.8	59.4	181.7	292.0	389.3	648.8	778.0	1297	1503	3970	11.94K	30.46K	85.32K
80	22.3	57.9	176.9	282.7	376.9	628.1	753.2	1255	1458	3843	11.54K	29.35K	81.98K
81	21.8	56.5	172.2	273.7	364.9	608.2	729.2	1215	1414	3720	11.15K	28.29K	78.78K
82	21.3	55.1	167.7	265.0	353.4	588.9	706.0	1177	1372	3602	10.78K	27.27K	75.71K
83	20.8	53.7	163.3	256.7	342.2	570.4	683.9	1140	1332	3489	10.42K	26.29K	72.78K
84	20.3	52.4	159.1	248.6	331.5	552.6	662.3	1104	1293	3379	10.08K	25.35K	69.98K
85	19.9	51.1	154.9	240.9	321.2	535.4	641.8	1070	1255	3273	9744	24.45K	67.29K
86	19.4	49.9	151.0	233.4	311.3	518.8	621.8	1036	1218	3172	9424	23.59K	64.72K
87	19.0	48.7	147.1	226.2	301.7	502.8	602.7	1004	1183	3073	9117	22.76K	62.26K
88	18.6	47.5	143.4	219.3	292.4	487.4	584.3	973.8	1149	2979	8821	21.96K	59.91K
89	18.2	46.4	139.8	212.6	283.5	472.6	566.4	944.1	1116	2887	8536	21.19K	57.65K
90	17.8	45.3	136.2	206.1	274.9	458.2	549.1	915.2	1084	2799	8261	20.45K	55.48K
91	17.4	44.2	132.8	199.9	266.6	444.4	532.6	887.7	1053	2714	7996	19.75K	53.41K
92	17.0	43.2	129.5	193.9	258.6	431.0	516.6	861.0	1023	2632	7741	19.07K	51.42K
93	16.6	42.1	126.3	188.1	250.9	418.2	501.2	835.3	994.2	2552	7496	18.41K	49.52K
94	16.3	41.2	123.2	182.5	243.4	405.7	486.2	810.4	966.3	2476	7259	17.78K	47.69K
95	15.9	40.2	120.2	177.1	236.2	393.7	471.8	786.4	939.3	2402	7030	17.18K	45.94K
96	15.6	39.3	117.3	171.9	229.3	382.1	458.0	763.3	913.2	2331	6810	16.6K	44.26K
97	15.3	38.4	114.4	166.9	222.6	370.9	444.7	741.1	887.9	2262	6598	16.04K	42.65K
98	15.0	37.5	111.7	162.0	216.1	360.1	431.6	719.4	863.4	2195	6393	15.5K	41.1K
99	14.6	36.7	109.0	157.3	209.8	349.7	419.1	698.5	839.7	2131	6195	14.98K	39.62K
100	14.3	35.8	106.4	152.8	203.8	339.6	407.1	678.5	816.8	2069	6005	14.48K	38.2K
101					197.9	329.8	395.4	659.0	794.6	2009	5821	14K	36.84K
102				144.2	192.2	320.4	384.2	640.3	773.1	1950	5643	13.54K	35.53K
103				140.1	186.8	311.3	373.3	622.1	752.3	1894	5472	13.09K	34.27K
104				136.1	181.5	302.5	362.6	604.4	732.1	1840	5307	12.66K	33.06K
105				132.3	176.4	294.0	352.5	587.5	712.6	1788	5147	12.25K	31.91K
106				128.6	171.4	285.7	342.6	571.0	693.6	1737	4993	11.86K	30.79K
107				125.0	166.7	277.8	333.0	555.1	675.3	1688	4844	11.47K	29.72K
108				121.6	162.0	270.1	324.0	540.0	657.5	1640	4700	11.11K	28.69K
109				118.2	157.6	262.6	314.9	524.9	640.3	1594	4561	10.75K	27.71K
110				115.0	153.2	255.4	306.4	510.7	623.5	1550	4427	10.41K	26.76K
111				111.8	149.0	248.4	297.9	496.4	607.3	1507	4297	10.08K	25.84K
112				108.8	145.0	241.6	289.9	483.1	591.6	1465	4172	9763	24.96K
113				105.8	141.1	235.1	281.9	469.8	576.4	1425	4051	9456	24.12K
114				103.0	137.2	228.7	274.4	457.4	561.6	1386	3933	9161	23.31K
115				100.2	133.6	222.6	267.0	444.9	547.3	1348	3820	8876	22.52K
116				97.6	130.0	216.7	260.0	433.4	533.4	1311	3711	8601	21.77K
117				95.0	126.5	210.9	253.1	421.8	519.9	1276	3605	8336	21.05K
118				92.5	123.2	205.3	246.4	410.7	506.8	1241	3502	8080	20.35K
119				90.0	119.9	199.9	239.8	399.6	494.1	1208	3403	7832	19.68K
120				87.7	116.8	194.7	233.7	389.4	481.8	1176	3307	7594	19.03K
121				85.4	113.8	189.6	227.5	379.2	469.8	1145	3214	7364	18.41K
122				83.2	110.8	184.7	221.7	369.4	458.2	1114	3124	7142	17.81K
123				81.1	107.9	179.9	216.1	360.1	446.9	1085	3038	6927	17.23K
124				79.0	105.2	175.3	210.5	350.8	435.9	1057	2953	6720	16.68K
125				77.0	102.5	170.8	205.2	341.9	425.3	1029	2872	6519	16.14K
126				75.0	99.9	166.4	199.8	333.0	414.9	1002	2793	6326	15.62K
127				73.1	97.3	162.2	194.8	324.6	404.9	976.3	2717	6139	15.12K
128				71.3	94.9	158.1	190.0	316.6	395.1	951.1	2643	5958	14.64K
129				69.5	92.5	154.1	185.2	308.6	385.6	926.7	2571	5784	14.18K

Resistance versus Temperature 130 to 199°C

YSI Thermistor			45004	45005	45007	45017	45016	45006	45008			
			46004	46005	46007	46017	46016	46006	46008			
			46033	46030	46034	46037	46036	46031	46032			
			46043	46040	46044	46047	46046	46041				
44001A	44002A	44003A	44004	44005	44007	44017	44016	44006	44008	44011	44014	44015
44101A	44102A	44103A	44104A	44105A	44107A	44117A	44116A	44106A	44108A			
Ω												
25°C 100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
°C												
130			67.8	90.2	150.3	180.6	301.1	376.4	903.0	2501	5615	13.74K
131			66.1	87.9	146.5	176.1	293.5	367.4	880.0	2434	5452	13.31K
132			64.4	85.7	142.9	171.6	286.0	358.7	857.7	2369	5294	12.89K
133			62.9	83.6	139.4	167.6	279.3	350.3	836.1	2306	5141	12.49K
134			61.3	81.6	136.0	163.3	272.2	342.0	815.0	2244	4994	12.1K
135			59.8	79.6	132.6	159.3	265.5	334.0	794.6	2185	4851	11.73K
136			58.4	77.6	129.4	155.6	259.3	326.3	774.8	2128	4713	11.37K
137			57.0	75.8	126.3	151.9	253.1	318.7	755.6	2072	4580	11.02K
138			55.6	73.9	123.2	148.1	246.9	311.3	736.9	2018	4450	10.69K
139			54.3	72.2	120.3	144.7	241.1	304.2	718.8	1965	4325	10.36K
140			53.0	70.4	117.4	141.2	235.3	297.2	701.2	1914	4204	10.05K
141			51.7	68.8	114.6	137.7	229.6	290.4	684.1	1865	4087	9746
142			50.5	67.1	111.9	134.5	224.2	283.8	667.5	1817	3974	9455
143			49.3	65.5	109.2	131.3	218.9	277.4	651.3	1770	3864	9173
144			48.2	64.0	106.7	128.4	214.0	271.2	635.6	1725	3757	8901
145			47.0	62.5	104.2	125.2	208.7	265.1	620.3	1681	3654	8637
146			45.9	61.1	101.8	122.3	203.8	259.2	605.5	1639	3555	8383
147			44.9	59.6	99.4	119.6	199.4	253.4	591.1	1598	3458	8137
148			43.8	58.3	97.1	116.7	194.5	247.8	577.1	1558	3364	7899
149			42.8	56.9	94.9	114.0	190.1	242.3	563.5	1519	3274	7669
150			41.8	55.6	92.7	111.5	185.9	237.0	550.2	1481	3186	7447
151			40.9	54.5	90.8	109.0	181.7	231.7	537.7			
152			40.0	53.3	88.8	106.5	177.5	226.6	525.1			
153			39.1	52.1	86.8	104.1	173.5	221.7	512.9			
154			38.2	50.9	84.9	101.8	169.6	216.9	501.0			
155			37.3	49.7	82.9	99.4	165.7	212.2	489.3			
156			36.5	48.7	81.1	97.3	162.1	207.6	478.1			
157			35.7	47.6	79.3	95.1	158.5	203.2	467.2			
158			34.9	46.5	77.6	93.0	155.0	198.8	456.6			
159			34.1	45.5	75.9	91.0	151.6	194.6	446.2			
160			33.4	44.5	74.2	89.0	148.3	190.5	436.1			
161			32.7	43.5	72.6	87.1	145.1	186.5	426.3			
162			32.0	42.6	71.0	85.2	141.9	182.6	416.7			
163			31.3	41.7	69.5	83.3	138.4	178.7	407.4			
164			30.6	40.8	68.0	81.5	135.8	175.0	398.3			
165			29.9	39.9	66.4	79.7	132.8	171.4	389.5			
166			29.3	39.0	65.1	78.1	130.1	167.8	380.8			
167			28.7	38.2	63.7	76.4	127.3	164.4	372.4			
168			28.1	37.4	62.3	74.8	124.6	161.0	364.3			
169			27.5	36.6	61.0	73.2	122.0	157.7	356.3			
170			26.9	35.8	59.7	71.7	119.4	154.5	348.6			
171			26.3	35.1	58.5	70.1	116.9	151.4	341.0			
172			25.9	34.3	57.3	68.7	114.5	148.3	333.6			
173			25.2	33.6	56.1	67.3	112.1	145.3	326.4			
174			24.7	32.9	54.9	65.9	109.8	142.4	319.4			
175			24.2	32.2	53.8	64.5	107.5	139.6	312.7			
176			23.7	31.6	52.7	63.2	105.3	136.8	305.9			
177			23.2	30.9	51.6	61.9	103.2	134.1	299.4			
178			22.8	30.3	50.5	60.7	101.1	131.5	293.1			
179			22.3	29.7	49.5	59.4	99.0	128.9	286.9			
180			21.9	29.1	48.6	58.2	97.1	126.3	281.0			
181			21.4	28.5	47.5	57.1	95.1	123.9	275.0			
182			21.0	27.9	46.6	55.9	93.2	121.5	269.3			
183			20.6	27.4	45.6	54.8	91.3	119.1	263.7			
184			20.2	26.8	44.7	53.7	89.5	116.8	258.3			
185			19.8	26.3	43.8	52.7	87.8	114.6	253.0			
186			19.4	25.8	43.0	51.6	86.0	112.4	247.7			
187			19.0	25.3	42.1	50.6	84.3	110.2	242.7			
188			18.6	24.8	41.3	49.6	82.7	108.1	237.7			
189			18.3	24.3	40.5	48.6	81.1	106.1	232.9			
190			17.9	23.8	39.7	47.7	79.5	104.1	228.2			
191			17.6	23.4	39.0	46.8	78.0	102.2	223.6			
192			17.2	22.9	38.2	45.9	76.5	100.2	219.1			
193			16.9	22.5	37.5	45.0	75.1	98.4	214.7			
194			16.6	22.1	36.8	44.2	73.7	96.6	210.4			
195			16.3	21.7	36.1	43.4	72.3	94.8	206.2			
196			16.0	21.3	35.5	42.6	70.9	93.0	202.1			
197			15.7	20.9	34.8	41.8	69.6	91.3	198.2			
198			15.4	20.5	34.2	41.0	68.3	89.7	194.2			
199			15.1	20.2	33.5	40.2	67.1	88.0	190.4			

Resistance versus Temperature 200 to 250°C

YSI Thermistor			45004 46004 46033 46043	45005 46005 46030 46040	45007 46007 46034 46044	45017 46017 46037 46047	45016 46016 46036 46046	45006 46006 46031 46041	45008 46008 46032			
44001A 44101A	44002A 44102A	44003A 44103A	44004 44104A	44005 44105A	44007 44107A	44017 44117A	44016 44116A	44006 44106A	44008 44108A	44011	44014	44015
Ω												
25°C 100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
°C												
200			14.9	19.8	32.9	39.6	65.9	86.5	186.7			
201					32.3	38.8	64.7	84.9	183.1			
202					31.7	38.1	63.5	83.3	179.5			
203					31.2	37.4	62.3	81.9	176.0			
204					30.6	36.7	61.2	80.4	172.6			
205					30.0	36.0	60.1	79.0	169.3			
206					29.5	35.4	59.0	77.6	166.1			
207					29.0	34.8	58.0	76.2	162.9			
208					28.5	34.2	57.0	74.9	159.8			
209					28.0	33.6	56.0	73.6	156.8			
210					27.5	33.0	55.0	72.3	153.8			
211					27.0	32.4	54.0	71.0	150.9			
212					26.5	31.8	53.1	69.8	148.1			
213					26.1	31.3	52.1	68.6	145.3			
214					25.6	30.7	51.2	67.4	142.6			
215					25.1	30.2	50.3	66.2	139.9			
216					24.7	29.7	49.5	65.1	137.3			
217					24.3	29.2	48.6	64.0	134.8			
218					23.9	28.7	47.8	62.9	132.3			
219					23.5	28.2	47.0	61.8	129.9			
220					23.1	27.7	46.2	60.8	127.5			
221					22.7	27.2	45.4	59.8	125.2			
222					22.3	26.8	44.7	58.8	122.9			
223					22.0	26.3	43.9	57.8	120.7			
224					21.6	25.9	43.2	56.8	118.5			
225					21.3	25.5	42.5	55.9	116.3			
226					20.9	25.0	41.8	55.0	114.3			
227					20.5	24.6	41.1	54.1	112.2			
228					20.2	24.2	40.4	53.2	110.2			
229					19.9	23.8	39.7	52.3	108.3			
230					19.5	23.4	39.1	51.5	106.4			
231					19.2	23.1	38.5	50.6	104.5			
232					18.9	22.7	37.8	49.9	102.6			
233					18.6	22.3	37.2	49.0	100.8			
234					18.3	22.0	36.6	48.2	99.1			
235					18.0	21.6	36.0	47.4	97.3			
236					17.7	21.3	35.5	46.7	95.7			
237					17.4	20.9	34.9	46.0	94.0			
238					17.1	20.6	34.4	45.2	92.4			
239					16.9	20.3	33.8	44.5	90.8			
240					16.6	20.0	33.3	43.8	89.2			
241					16.3	19.6	32.8	43.1	87.7			
242					16.1	19.3	32.2	42.4	86.2			
243					15.8	19.0	31.7	41.8	84.8			
244					15.6	18.7	31.3	41.1	83.3			
245					15.3	18.5	30.8	40.5	81.9			
246					15.1	18.2	30.3	39.9	80.5			
247					14.9	17.9	29.8	39.3	79.2			
248					14.6	17.6	29.4	38.7	77.9			
249					14.4	17.4	28.9	38.1	76.6			
250					14.2	17.1	28.5	37.5	75.3			

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

Glossary

316SS A stainless steel containing approximately 2% Mn, 2% Mo,12% Ni and 17% Cr, with the balance Fe and trace C, S, P and Si.

Absolute zero The lowest possible temperature; the temperature at which thermal energy is at a minimum. Defined as 0 Kelvin or -273.15°C.

Accuracy Measure of the closeness of a reading to the actual value.

Ambient range In general, the human environmental range, -20 to +50°C. The industrial application ambient range is 0 to 70°C, the military range is -55 to +125°C.

Ambient temperature Temperature of the background or surrounding environment.

Ampere (A) SI unit of electric current.

AWG American Wire Gauge.

Beta value An indicator of the shape of the resistance vs temperature curve.
$\beta = \ln (R_T/R_{To})/(1/T-1/T_o)$

Calibration Documenting a sensor's value as determined by a precise measurement.

Celsius (Centigrade,°C) A temperature scale defined by setting the ice point of water at 0°C and the boiling point of water at 100°C.

Control point The temperature at which the controlled system is to be maintained.

Current (I) The rate of flow of an electric charge, usually expressed in amperes.

Current proportioning A type of temperature controller which provides a control current proportional to the difference between the measured temperature and the control point.

Direct current (dc) Current that flows in one direction only. The type of current that is supplied by batteries.

Degree (°) An increment of a temperature scale. The size of a degree is different in different temperature scales; for example, 1°C = 1.8°F

De-rated A deliberate reduction in the rating of a component to improve reliability.

Deviation The difference between an observed and a fixed value; the difference between the observed temperature and the set point of the controller.

Dielectric Any material capable of sustaining a steady electric field; an insulator.

Differential The difference between the temperature at which a controller turns heat off and the temperature at which the heat is turned on, in degrees.

Dissipation constant The amount of power a thermistor can dissipate before experiencing an increase in temperature, usually expressed in mW/°C.

Drift A slow variation of any performance characteristic of a device or circuit.

Dumet A copper-clad, nickel-iron alloy with a thermal expansion closely matching that of glass. Provides hermetic seals in soft glasses.

emf Electromotive force. Difference of electrical potential that drives currents through circuits. Unit is the volt.

Epoxy A flexible resin used in coatings and adhesives. Also called epoxy resin.

Error The difference between the correct or desired value and the actual reading.

Fahrenheit A temperature scale defined by setting the freezing point of water at 32°C and the boiling point of water at 212°C.

Galvanometer An instrument that measures small electrical currents by means of deflecting magnetic coils.

Ground A conducting path between an electrical circuit and the earth or some conductor serving in its place.

GSFC S-311-P-18 A specification issued by the Goddard Space Flight Center covering thermistors for use in space flight.

Heat Energy in the process of transferring between a system and its surroundings as a result of temperature differences.

Heat transfer The process whereby thermal energy flows from a high energy body to a low energy body via conduction, convection, or radiation.

Hermetic Airtight

Hysteresis The retardation or lagging of an effect behind the cause of the effect.

ID Inside diameter.

Input impedance The small signal impedance measured between the input terminals of a network.

Insulation resistance The resistance between two conductors, or between a conductor and ground, when they are separated only by insulating material.

Interchangeable Able to substitute one sensor for another while maintaining consistent readings.

Interchangeability error A measurement error that can occur if two or more probes are used to make the same measurement. It is caused by a slight variation in characteristics of different probes.

Isothermal Occurring at constant temperature.

ITS-90 International Temperature Scale of 1990.

Kelvin (K) An absolute temperature scale based on the Celcius scale; the thermodynamic temperature scale. One kelvin is the same temperature interval as one degree Celcius, and 0K = -273.15°C.

Linearity deviation The difference between the actual response of a device and its theoretical straight-line approximation.

Maximum operating temperature The temperature above which a device will not safely operate.

Maximum power rating The maximum power that a device can safely handle.

Metrology The science of measuring.

Mica A transparent mineral used to make the cross supporting the platinum wire windings in an SPRT. One of the best electrical insulators.

Microamp (μA) One millionth of an ampere, 10^{-6} A.

MIL-T-23648 The US Department of Defense general specification for thermistors.

Milliamp (mA) One thousandth of an ampere, 10^{-3} A.

Millivolt (mV) One thousandth of a volt, 10^{-3} V.

Negative temperature coefficient (NTC) Decreasing resistance with increasing temperature.

NIST National Institute of Standards and Technology. The US government agency that defines measurement standards in the United States.

NPT National Pipe Thread.

OD Outer diameter.

Offset The difference in temperature between the set point and the actual process temperature.

Ohms (Ω) SI unit of electrical resistance.

Ohm's law A relationship between voltage (emf), current and resistance in an electrical component carrying direct current. E = IR.

On/Off controller A temperature controller that turns a heater fully on or fully off.

Operating Range The specified range over which a device is expected to operate.

Platinum resistance element An element made of platinum whose resistance varies with temperature.

Positive temperature coefficient (PTC) Increasing resistance with increasing temperature.

Power (p) Rate of doing work, in Watts (W).

Probe Usually refers to a sensing element built into a housing that is physically suitable for insertion into the environment or substance to be measured.

PVC Polyvinyl chloride.

Range An area between two limits within which a sensor or instrument is operational; the extent of the sensor's or instrument's capabilities.

Rankine (°R) An absolute temperature scale based on the Fahrenheit scale, where one degree Rankine is the same temperature interval as one degree Fahrenheit, and 0°R = -459.67°F.

Repeatability The ability of a sensor or instrument to give the same reading or output under repeated identical conditions.

Resistance (R) The resistance to the flow of electric current measured in ohms (Ω).

Resistance ratio The ratio of the resistance of a thermistor at two different temperatures, usually resistance at 25°C to resistance at 125°C (R_{25}/R_{125}).

Resistor An electrical component designed to provide a known resistance.

Response time The time required to change the output of an electronic circuit after a sudden change in input. Used by YSI as the time required to sense 90% of a temperature change. See Time Constant.

Selection The examination of a device for compliance to a specific characteristic, usually associated with size or measurement tolerance.

Self-heating The effect of driving, usually resistive devices, at a level which induces a bias in the measured value.

Sensitivity The minimum change in temperature to which the instrument or sensor will respond.

Set point The temperature which a controller is set to maintain.

SI System Internationale. The standard metric system of units.

Sinter To form small particles into larger particles, cakes or masses by heating without liquifying.

Solid wire A wire with no stranding.

Span The difference between the upper and lower limits of a range.

SPRT Standard Platinum Resistance Thermometer. A primary temperature standard calibrated to fixed-points of nature such as the triple-point of water.

Stability The ability of an instrument or sensor to maintain a constant output given a constant input.

Steinhart & Hart equation An equation which calculates resistance as a function of temperature for negative temperature coefficient thermistors.

Stranded wire Wire whose conductor is woven from individual wires or strands.

Teflon DuPont trademark name for polytetrafluoroethene. Used to insulate electrical conductors. Noted for its chemical inertness and heat resistance.

Temperature A measure of the degree of hotness or coolness of some sample. Temperature is to heat, what voltage is to power.

Temperature scale The scale assigned to allow determination of temperature. The International Practical Temperature Scale is reviewed for fit to the thermodynamic scale at approximately 20-year intervals. There are four practical scales, Celsius °C, Kelvin K, Fahrenheit °F, Rankine °R, and one theoretical scale, the Thermodynamic Temperature Scale. The scales differ in end points and value of divisions.

Thermal conductivity The ability of a material to conduct thermal energy.

Thermal expansion An increase in size due to an increase in temperature.

Thermal gradient The distribution of a differential temperature through a body or across a surface.

Thermal shock The shock which results when a body is subject to sudden changes in temperature.

Thermilinear component Two or three thermistor disks built into one bead which, when used in a network, provides a linear resistance vs temperature curve.

Thermilinear network One Thermilinear component and two or three resistors that can be wired to provide linear resistance response to temperature.

Thermistor A temperature-sensitive resistor made of metal oxides sintered into disks which exhibits a large change in resistance for a small change in temperature.

Time constant The time required for a sensor to register 63.3% of a change in temperature.

Tolerance The range between allowable maximum and minimum values.

UL Underwriters Laboratories, Inc. An independent laboratory that establishes standards for commercial and industrial products.

Volt (E) SI unit of electrical potential difference.

Voltage An electrical potential measured in volts.

Voltage divider Usually a series of resistors used to divide the supply voltage in proportion to the value of each resistor in the string.

Watt SI unit of power.

Wheatstone bridge A network of four resistances, an emf source and a galvanometer connected so that when the four resistances are matched, the galvanometer will show a zero deflection or null reading.

Zero power resistance The resistance of a thermistor with no power being dissipated.

Fax reply to YSI at 513 767-9353

Temperature Products Customer Service

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Organization _____

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Tell us about your application. Sketch your installation or sensor if you like.

Information about Other YSI Products

We also make sensors and instruments for measurement and control of temperature in the lab and in patient care. Our meters and monitors measure water quality and YSI analyzers help control bioprocessing. We'll send you information about any of our products that interest you–just mail the postcard or call **800 765-4974.**

Please send me the information I've requested below.
For a quicker response, call us at **800 765-4974.**

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- ❑ Water Quality Monitoring
- ❑ Blood Glucose & Lactate Analyzers
- ❑ Sugar, Starch, Alcohol Analyzers

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Sales Policy

New Accounts

To quickly qualify for open account status, please supply this information to our credit manager:

- Dun & Bradstreet rating or Duns number
- Two credit references from vendors
- Bank reference
- Name of chief executive officer or president
- Name of treasurer
- Name of controller
- Credit limit desired

Terms of Sale

Net 30 days from invoice date. We observe these terms rigidly. Failure to meet them may result in non-acceptance of new orders. Shipping prepaid and added, FOB Yellow Springs, Ohio.

OEM and Contract Discounts

Qualification for OEM discounts requires that these conditions be met:

- Use of YSI product in a fashion that's integral with the product–wired in.
- Description of application in the simplest non-proprietary terms.
- Expected use rate
- Permission to advertise if use is not proprietary.
- We will negotiate all agreements based on product and volume. Basically all purchases of similar products may be mixed for discount. Delivery schedules are a significant factor in developing the terms of a purchase agreement.
- Contact your local manufacturers representative or YSI Customer Service.

Order Change and Cancellation

Our terms for order cancellation or change are:

- Any cancellation of orders for stock products after order entry must be 30 days before shipping date.
- Any cancellation after order entry of build-to-order or build-to-specification products will be subject to a minimum $50 or 15% charge, whichever is greater
- Any order for which material or labor have been expended will carry cancellation charges equal to the percentage completed or $50, whichever is greater.
- Any customer change which adds cost to the manufacture of products will be charged at normal overhead and profit.

Returned Goods

We will accept for return certain of our products.

- Cataloged thermistors
- Certain other products which have been negotiated before order placement.

Return for credit requires:

- Customer Service gives prior approval, RA number and shipping instructions
- Products are in new condition
- Products are not obsolete

Minimum Orders

Our minimum order requirements are:

- For thermistor components, 100 pieces. For smaller quantities, contact our distributors or stocking representatives.
- For all types of sensor assemblies (mixed), $75.

Exceptional Service

Expected delivery for manufactured-to-order products is normally 4 weeks. When standard delivery needs to be improved with certainty, we offer exceptional service.

A. Two-week delivery assuming material availability for all pre-engineered products.

B. Best possible delivery will include full force effort (overtime) to complete and ship the product in minimum time.

Additional charges for A service are 25% of the normal price and 50% for B service.

On occasion, because of material shortages, exceptional service will be unable to meet your needs. Call Customer Service to establish that materials are available.

Limited Warranty

We warrant our products against defects in materials and workmanship when the products are used according to their ratings and specifications. Our maximum liability is limited to repair or replacement (at our option) of defective products.

For sensors, sensor assemblies and special products, the warranty period is 1 year from shipment date. We will handle warranty repairs and replacements expeditiously. Contact Customer Service for instructions and best turn-around time.

Call us to discuss your application at 800 765-4974. Fax 513 767-9353

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